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MSFN RELIABILITY FOR A LUNAR LANDING MISSION

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MSFN RELIABILITY FOR A LUNAR LANDING MISSION

May, 1969

MSFN RELIABILITY FOR A LUNAR LANDING MISSION

Prepared by

Applied Physics Laboratory Contract NOw 62-0604C Task N

Under Technical Direction of F. Kalil and R. Wigand

May, 1969

Approved by_

/ J. P. Shaughnessy, Head

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FOREWORD

by F. Kalil

This report is the second in a series of reports to be presented by the Applied Physics Laboratory (Contract NOw 62-0604-C, Task N), regarding the reliability of the Manned Space Flight Network (MSFN). The reliability analyses contained herein are based primarily on failures experienced during flight support status. Previous analyses and predictions of MSFN reliability for supporting the lunar orbiting mission (Apollo 8, AS-503) were reported prior to the mission. These latter predictions correlated with the actual experience during the AS-503 mission. This report presents similar predictions about the MSFN reliability for supporting the forthcoming lunar landing, which is scheduled for July, 1969. The reliability predictions contained herein differ from the previous ones' in that these predictions: (1) incorporate data from a larger number of missions; and (2) consider the fact that two manned vehicles must be supported simultaneously during the phases when the LEM descends, lands and stays on the lunar surface, ascends, and docks with the CSM. These phases put the MSFN to a more severe use; however, the predictions herein indicate that the MSFN will be able to successfully support the mission. Although the reliability predictions are contained in the body of the report, they are repeated here in summary form (Tables I and II) for completeness and emphasis. The mission phases referred to in Tables I and II are diagrammatically depicted in the following Figure-a.

As shown in Tables I and II, the MSFN's reliability is predicted to be ~ 0.999 for each of the support functions during each phase of a lunar landing mission. Redundancy in both hardware and mission coverage were considered, and all failures (hardware, software, and operator) were considered. The single site availability is predicted to be ~ 0.86 on the average for each of the support functions listed for the earth orbital phases; however, the availability for each of the functions approaches ~ 0.997 shortly after translunar injection when three or more stations are in view of the spacecraft. It should be noted that the availability of ~ 0.86 for a single site could be misleading, primarily because not each site must necessarily support every function in the earth orbital phase to insure success of the mission. For instance, MIL, GBM, and GBI provide redundant coverage during the launch phase; and the network provides 17 contacts, about 7.5 minutes each, via individual stations during the first two orbits of the earth packing orbit phase for check-out of the spacecraft systems.

¹ "Performance Evaluation of the Unified S-Band Ground System for AS-205," GSFC report X-834-68-485, Dec. 1968.

Table I. Summary of Lunar Mission Functional Support Reliability

	I) Detern of Spa vs vs	I) Determine Position of Spacecraft(s) vs Time (tracking/navigation)	II) Main Comn	Communication with Spacecraft(s)	III) Mo c: Status a	III) Monitor Space- craft(s) Status and Systems (telemetry/television)	IV) Senc Up Spac	IV) Send Commands/ other Up Data to Spacecraft(s)
Mission Phase	Single Site MTBF	Reliability (Multiple Site Coverage)	Single Site MTBF	Reliability (Multiple Site Coverage)	Single Site MTBF	Reliability (Multiple Site Coverage)	Single Site MTBF	Reliability (Multiple Site Coverage)
Launch, Insertion, Earth Parking Orbit	119 hrs	0.99893	424 hrs	0.99982	107 hrs	0.99876	127 hrs	0.99925
Translunar Injection, Transposition and Docking	119 hrs	0.99975	424 hrs	66666*0	107 hrs	0.99964	127 hrs	92666.0
Translunar* Flight	119 hrs	0.99731	191 hrs	0.99995	107 beg	0.99636	127 hrs	0.99751
Lunar Stay,* LM; Lunar Orbit CSM	119 hrs	0.99731	191 hrs	0.99995	107 hrs	98968•0	127 hrs	0.99751
Transearth Flight	119 hrs	0.999978	191 hrs	*666666*0	107 hrs	0.999962	127 hrs	0.999981
Entry	119 hrs	0.99893	424 hrs	0.99982	107 hrs	0.99876	127 hrs	0.99925

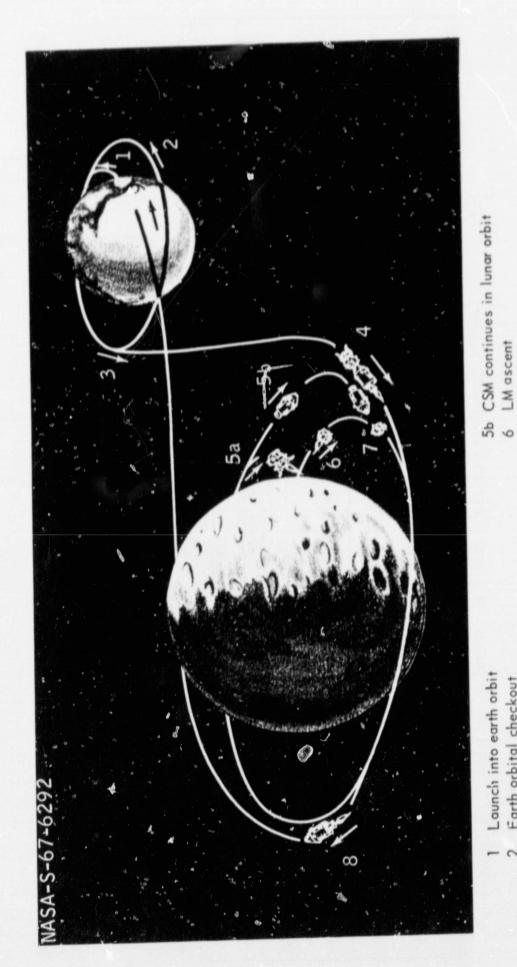
*Two spacecraft

Table II. Summary of Lunar Mission Functional Support Availability

これにはなるとのは本事をなるというでしていました。

Send Commands- other Up Data to Spacecraft(s)	Availability (Multiple Site Coverage)*	0.995 ≤ A
IV) Send Commands- other Up Data to Spacecraft(s)	Single Site Availability	0.83
III) Monitor Spacecraft(s) Status and Systems lemetry/television)	Availability (Multiple Site Coverage)*	0.997 ≤ A
III) Monitor Spacecraft(s) Status and Systems telemetry/television)	Single Site Availability	0.86
II) Maintain Voice Communication with Spacecraft(s)	Availability (Multiple Site Coverage)*	0.999 ≤ A
II) Maintai Communi with Spacecra	Single Site Availability	0.92
) Determine Position of Spacedraff(s) vs Time (tracking/navigation)	Availability (Multiple Site Coverage)*	0.997 ≤ A
I) Determine Position of Spacedraff(s) vs Time(tracking/navigation)	Single Site Availability	98.0

*Three or more sites will see the spacecraft simultaneously after transposition and docking.



Separate CM, enter atmosphere, and land Inject CSM into trajectory toward earth Rendezvous and docking LM ascent Inject into trajectory toward moon Transposition and docking Deboost into lunar orbit Earth orbital checkout

Figure a-Typical lunar landing mission.

LM descent to surface

2 33 35 4 4

LUNAR LANDING MISSION RELIABILITY STUDY

1. Introduction

A study has been done to estimate the mission support function reliability of the Manned Space Flight Network for a lunar landing mission. This is a follow up effort to a previous study done for a lunar orbital mission. The lunar orbital mission study was submitted to the Manned Flight Planning and Analysis Division (MFPAD) at Goddard Space Flight Center in early December, 1968. The lunar orbital mission study was also included in the October-December 1968 Quarterly Progress Report of the Manned Space Flight Network Study Program (Reference 1). This is the quarterly progress report by the Space Communications Group (CSC) of the Johns Hopkins Iniversity/Applied Physics Laboratory.

The present study extends previous work in several areas:

- (1) A more complex mission profile is considered with additional mission phases such as "transposition and docking," "lunar module descent and landing" included. The most significant additional complexity, from a MSFN reliability standpoint, is that during much of the mission, coverage must be provided for two spacecraft.
- (2) Failure and repair data for 5 missions has been utilized in compiling the reliability estimates. This data has been obtained from NOM and MMR mission status reporting for the AS-501, AS-204, AS-502, AS-503, and AS-205 missions. The last two listed missions provided data not available for the previous study. For the AS-503 and AS-205 missions it was necessary to reduce the data directly from the station submitted TWX reports since no post mission problem summaries were provided as had been done for the three earlier missions.
- (3) A summary tabulation of "Availability" is included in addition to summary and detailed tabulations of "Reliability." This is done to estimate, under certain assumptions, the effect of site down time. A discussion of the interpretation of "Availability," how it differs from "Reliability," and the assumptions made in determining the estimates is given in Sections (2) and (3).

Equipment failure data was translated into functional support reliability estimation by interconnecting, from a reliability standpoint, those equipments necessary for the support of the function assumed. Equipment redundancy and multiple site coverage were taken into account.

2. Summary of Results

Table I is a summary tabulation of site mean time between failure (MTBF) and overall Reliability via multiple site coverage for the four major MSFN support functions during each phase of the mission. Table IV is a more detailed tabulation of the same information with major support functions broken down into subfunctions.

The list of required support functions assumed for this study is given in Figure 1. The tables show that no functional MTBF, as estimated from the data, is less than 107 hours for a single site.

The reliability estimates are obtained from the MTBF estimate, an exponential failure law assumption, and a weighted combination of the site coverage time interval and number of sites covering depending upon mission phase. These reliability estimates give the probability of failure free support over a time interval by at least one site out of the total number of covering sites. The coverage time interval and number of sites covering depend upon mission phase.

Table II is a summary table of single site and multiple site coverage Availability for the four major MSFN support functions. These estimates are approximations which take into account the ratio of average repair time to mean time between failure for each equipment area and the amount of equipment required to support each function. The interpretation of these availability estimates differs from that of reliability in that reliability is a time dependent probability of failure free operation given that the time interval began with the site in the "up" state. Availability is an asymptotic or "steady state" probability of being in the "up" state after some time has passed and does not depend upon the state of things at the beginning of the time interval if a sufficiently long time interval is considered. This asymptotic probability (availability) is reached after a period of time has passed during which both failures and repairs have occurred. The estimates can be interpreted as measuring the probability of, at any arbitrary time during the mission, finding a site (or at least one of 3 sites) capable of supporting the function.

The estimates of reliability and availability can both be of interest from different viewpoints. Reliability is of more concern when a relatively short interval of time is considered during which it is essential that no failures occur. Availability is of more concern when a longer period of time has passed over which it is likely that failures (and hopefully rapidly completed repairs) have occurred and the probability of finding a site "up" is considered.

Table I. Summary of Lunar Mission Functional Support Reliability

	I) Detern of Sps vs (tracking	1) Determine Position of Spacecraft(s) vs Time (tracking/navigation)	II) Main Comn Spac	II) Maintain Voice Communication with Soacecraft(s)	III) Mo c Status (telemetr	III) Monitor Space- craft(s) Status and Systems (telemetry/television)	IV) Senc Up Spac	IV) Send Commands/ other Up Data to Spacecraft(s)
Mission Phase	Single Site MTBF	Reliability (Multiple Site Coverage)	Single Site MTBF	Reliability (Multiple Site Coverage)	Single Site MTBF	Reliability (Multiple Site Coverage)	Single Site MTBF	Reliability (Multiple Site Coverage)
Launch, Insertion, Earth Parking Orbit	119 hrs	0.99893	424 hrs	0.99982	107 hrs	0.99876	127 hrs	0.99925
Translunar Injection, Transposition and Docking	119 hrs	0.99975	424 hrs	66666.0	107 hrs	0.99964	127 hrs	0.99976
Translunar* Flight	119 hrs	0.09731	191 hrs	0.99995	107 hrs	0.99636	127 hrs	0.99751
Lunar Stay,* LM; Lunar Orbit CSM	119 hrs	0.99731	191 hrs	0.99995	107 hrs	989630	127 hrs	0.99751
Transearth Flight	119 hrs	0.999978	191 hrs	*666666*0	107 hrs	29666€*0	127 hrs	186666.0
Entry	119 hrs	0.99893	424 hrs	0.99982	107 hrs	0.99876	127 hrs	0.99925

*Two spacecraft

- 1 Determine Position of Spacecraft vs Time (Tracking/Navigation)
 - A) Receive Position/Time Data from MCC or MSFN
 - B) Acquire and Track Spacecraft and its Signals
 - C) Transmit Spacecraft Position/Time to MCC
 - D) Record Spacecraft Position/Time at Site
- 11 Maintain Voice Communications with Spacecraft
 - A) Receive voice from MCC
 - B) Transmit voice to spacecraft
 - C) Receive voice from spacecraft
 - D) Transmit voice to MCC
 - E) Record voice on site
- III Monitor Spacecraft Status and Systems
 - A) Receive telemetry from spacecraft
 - B) Process and transmit talemetry summaries to MCC
 - C) Record telemetry on site
 - D) Receive Television from spacecraft
- IV Send Commands/other Up Data to Spacecraft
 - A) Receive commands MCC
 - B) Process command data
 - C) Transmit up data to spacecraft
 - D) Verify that up data is transmitted
 - E) Verify that up data is received
 - F) Transmit command verification to MCC
 - G) Record command history on site
- V Maintain Site Proficiency
 - A) Test and maintain systems performance
 - B) Maintain voice communication with MCC and MSFN
 - C) Maintain teletype communication with MCC and MSFN
 - (D) Maintain data communication with MCC and MSFN
 - E) Monitor and maintain all fundamental power equipment
 - F) Receive and originate documents and reports

Figure 1-List of Mission Support Functions for each MSFN Site

Table II. Summary of Lunar Mission Functional Support Availability

I) Determine Position of Spacedraft(s)vs Time(tracking/navigation)	ne Position draft(s) ime navigation)	II) Maintain Voice Communication with Spacecraft(s)	Maintain Voice communication with Spacecraft(s)	III) Monitor Spacecraft(s) Status and Systems telemetry/television)	onitor raft(s) I Systems elevision)	IV) Send Commands- other Up Data to Spacecraft(s)	Send Commands— other Up Data to Spacecraft(s)
Single Site Availability	Availability (Multiple Site Coverage)*	Single Site Availability	Ayailability (Multiple Site Coverage)*	Single Site Availability	Availability (Multiple Site Coverage)*	Single Site Availability	Availability (Multiple Site Coverage)*
0.86	0.997 ≤ A	0.92	0.999 ≤ A	0.86	0.997 ≤ A	0.83	0.995 ≤ A

*Three or more sites will see the spacecraft simultaneously after transposition and docking.

3. Outline of Data Analysis

The following material summarizes how the basic data available for this study was reduced and utilized.

- (a) All failures and their associated down times reported during the five mission status periods were categorized into appropriate MSFN site equipment areas. The equipment category breakdown list has been presented in previous documents and is not attached to this study.
- (b) Mean time between failure (MTBF) estimates, taking down time into account, were calculated via computer programming for each equipment area. Down times for each equipment area were also tabulated.
 - Failure and down time data for certain equipment areas obtained over all five mission status periods is presented in histogram form in Appendix I. This data is representative of data used in the study.
- (c) By interconnecting the equipment areas (or "subsystems") as required for each support function of Figure 1 a functional reliability estimate for a site is obtained from the MTBF estimates of each equipment area and the time interval of site coverage for each mission phase.
 - An "overall" MTBF estimate for each function is also obtained by combining the estimates for each equipment area. The functional reliability estimates and overall MTBF estimate are not related in a simple exponential way since both series and parallel (redundant) equipment interconnections are involved and the resulting distribution of failure times is no longer exponential. In a redundancy situation for a failure to have occurred, all parallel paths must have failed. Table III presents the basic single site reliability data analysis for each support function. This table gives the single site reliabilities for each support function as calculated from the data for selected time intervals applicable to this study. All subsequent estimates of support reliability are based on Table III.
- (d) By considering total MSFN coverage, i.e., the number of sites which can view the spacecraft(s) during any given mission phase, an overall MSFN support function reliability estimate is obtained. In this situation "redundancy" is provided by the number of sites covering. This

For example, the Lunar Orbital Mission Reliability Study included in the October-December 1968, APL quarterly progress report mentioned in the introduction.

Table III

Function			gle Site Relia n Over Time	•	
	T = .133 hr	T = 1.0 hr	T = 2.0 hr	T = 8.0 hr	T = 14.0 hr
I A B C D	.99893 .99953 .99934 .99967 .99945	.99199 .99656 .99452 .99760 .99595	.98405 .99313 .98911 .99522 .99192	.93758 .97285 .95741 .98105 .96811	.89354 .95247 .92645 .96708 .94486
II A B C D E	.99982 .99984 .99984 .99984 .99984	.99882 .99884 .99854 .99884 .99884	.99766 .99880 .99769 .99769 .99880	.99054 .99083 .99065 .99065 .99083	.98321 .98402 .98367 .98367 .98402 .98402
III A B C	.99876 .99983 .99913 .99945	.99080 .99883 .99357 .99593	.98170 .99768 .98717 .99188	.92882 .99081 .94977 .96795	.87877 .98395 .91376 .94459
IV A B C D F G	.99925 .99938 .99942 .99981 .99955 .99975 .99945	.99227 .99542 .99574 .99861 .99660 .99826 .99593	.98462 .99087 .99151 .99723 .99320 .99652 .99188 .99151	.93989 .96401 .96648 .98882 .97309 .98608 .96795	.89722 .93788 .93013 .98027 .95338 .97559 .93695

"redundancy" varies depending upon whether one or two spacecraft are covered. From a reliability standpoint it is found that dual sites provide very little redundancy when a single spacecraft is considered. A summary of site coverage for a lunar mission is given in Figure 2. The detailed information from which the summary of Figure 2 was obtained is included in reference 1. This reference described in detail coverage for a night launch in August 1969 involving translunar injection over the Atlantic. The first lunar landing mission may well occur in July 1969 with translunar injection over the Pacific. These missions would differ in detail as to which sites covered when, but the overall summary of coverage as given in Figure 2 should apply to either.

A summary table of site mode support capability is given in Figure 4. It has been assumed in this study that 30 ft antenna sites can "back up" 85 ft antenna sites at lunar distance in the PM modes. (Contingency" modes or modes other than mode 2 might have to be used.) The 30 ft. antenna sites cannot "back up" the 85 ft. antenna sites at lunar distance in the FM modes which includes television. These assumptions can be inferred from Figure 4. Examples of the variation in equipment redundancy for certain USB areas as a function of site coverage is shown in Figure 3. Implications for other on site equipment existing in the same quantities as those selected for illustration can be obtained from Figure 3.

(e) In estimating "availability" the ratio of average down time to mean time between failure can be used when both the failure times and repair times are exponentially distributed;

$$A \approx 1 - \frac{MTR}{MTBF} + \left(\frac{MTR}{MTBF}\right)^2$$

For this study availability estimates were obtained using average down times for each equipment area but including only those repairs completed within 30 hours in calculating the average down time. The histogram examples of down time data even in Appendix I show a "bi model" or even "multi model" distribution of down times. Much of this is due to "logistics time" during mission status contributing to down times as long as two weeks or so. Such lengthy down times are assumed not to be typical of mission flight periods. It is assumed that every effort would be made during pre launch mission status to provide necessary spares and if needed, replacement could be flown to sites relatively quickly while a mission is in progress.

If "logistics down times" are not considered the data indicates that in most equipment areas most failures are repaired within one day with a typical average down time of about 8 hours.

LUNAR LANDING MISSION REI

Mission phase	Essential data/ major decisions	Duration of single site coverage interval	Required MSFN s
(A) Launch, Insertion Earth orbit	(a) Earth orbit determination (b) Translunar injection	Approximate 8 min on 80 min off ** (typical Earth orbit coverage)	i Dotermine positi spacecraft versu (tracking√navige
	go∕no gọ		II Maintain voice c cation with space
			III Monitor spacecre and systems
			IV Send commands, up data to space
(B) SIV B Separation, transposition and docking	(a) Lunar landing determination milestorie	Approximate 120 min	Determine posit spacecraft vers (tracking/navige
			II Maintain voice (cation with space
			III Monitor spacecrs and systems
			IV Send commands up data to spac

^{*}AS DEFINED IN THE MSFN SUPPORT FUNCTION LIST FIG. 1

**DURING "OFF" PERIODS FUNCTION V (MAINTAIN SITE PROFIL

***INCLUDES WING SITE

TABLE IV-1 MABILITY NOMINAL OPERATING PARAMETERS FOR MSFN AND SPACECRAFT

ommuni- ecraft on of Js time ring dop and	PM modes low LM PM modes rum LM PM modes	€° - < □00 < □00 ш < □0 < □0 < □0 < □0 < □0				h con b		functi	on car	able of be in	contai Oi	851 d	pr 30'	One sp 301-S \$18.0 171.8 400.5 240.6 740.7 467.3 436.9 740.7 716.3 860.9	30° - D 318.0 180.4 400.5 240.6 740.7 494.1 437.3 740.7 716.3 861.3	85, 318.0 180.4 400.5 240.6 740.7 494.1 437.3 740.7 716.3 861.3	Two sp 30'-5 318 0 171.8 400.5 240.6 740.7 467.3 436.9 740.7 716.3 860.9 152.7	30'-D 318.0 171.3 400.5 240.6 740.7 467.3 436.9 716.3 860.9	851 318.0 171.8 400.5 240.6 740.7 467.3 436.9 740.7 716.3 860.9
on of stime tion) ommuni- ecraft on of TL PM slo TL PM ror TL other PM craft on of PM stime right stommuni- ecraft ommuni- ecraft PM slo TV TL plo Stime right stommuni- ecraft PM slo TV TL plo Stime right stommuni- ecraft PM slo TL PM slo TV TL plo TL PM slo	oppler ngle PM nodes, /Hit nodes low FLM PM modes ormal TLM FM modes V FLM FM modes V FLM FM modes V FLM FM modes V FLM FM modes V	BUD 4BUD 4BU 4BU 4BU 4BU 4B			301	851	or 30'				-			\$18.0 171.8 400.5 240.6 740.7 467.3 436.9 740.7 716.3	318.0 180.4 400.5 240.6 740.7 494.1 437.3 740.7 716.3 861.3	318.0 180.4 400.5 240.6 740.7 494.1 437.3 740.7 716.3 861.3	318 0 171.8 400.5 240.6 740.7 467.3 436.9 740.7 716.3 860.9	318.0 171.3 400.5 240.6 740.7 467.3 436.9 740.7 716.3 860.9	318.0 171.8 400.5 240.6 740.7 467.3 436.9 740.7 716.3 860.9
on of stime tion) ommuni- ecraft on of TL PM slo TL PM ror TL other PM craft on of PM stime right stommuni- ecraft ommuni- ecraft PM slo TV TL plo Stime right stommuni- ecraft PM slo TV TL plo Stime right stommuni- ecraft PM slo TL PM slo TV TL plo TL PM slo	oppler ngle PM nodes, /Hit nodes low FLM PM modes ormal TLM FM modes V FLM FM modes V FLM FM modes V FLM FM modes V FLM FM modes V	BUD 4BUD 4BU 4BU 4BU 4BU 4B	2 =					25	min	251	(In	25		171.8 400.5 240.6 740.7 467.3 436.9 740.7 716.3	180.4 400.5 240.6 740.7 494.1 437.3 740.7 716.3 861.3	180.4 400.5 240.6 740.7 494.1 437.3 740.7 716.3 861.3	171.8 400.5 240.6 740.7 467.3 436.9 740.7 716.3 860.9	171.3 400.5 240.6 740.7 467.3 436.9 740.7 716.3 860.9	171.8 400.5 240.6 740.7 467.3 436.9 740.7 716.3 860.9
ommuni- ecraft on of Js time ring dop more recreft wow on of Js time ring dop more recreft work with the recreft with the recreft with the recreeks wit	PM modes, /Hit was low LM PM modes ormal LM TLM TLM TLM TLM TLM TLM TLM TLM TLM													400.5 240.6 740.7 467.3 436.9 740.7 716.3	400.5 240.6 740.7 494.1 437.3 740.7 716.3 861.3	400.5 240.6 740.7 494.1 437.3 740.7 716.3 861.3	400.5 240.6 740.7 467.3 436.9 740.7 716.3 860.9	400.5 240.6 740.7 467.3 436.9 740.7 716.3 860.9	400.5 240.6 740.7 467.3 436.9 740.7 716.3 860.9
ommuni- ecraft PM slo TL PM nor TL ift status TY TL pla S I' other craft on of Js time ition) ommuni- ecraft PM ov H pM	PM modes, His PM modes low LM PM modes ormal LM FM modes V LM Layback IV B													240 6 740.7 467.3 436.9 740.7 716.3	240.6 740.7 494.1 437.3 740.7 716.3 861.3	240.6 740.7 494.1 437.3 740.7 716.3 861.3	240.6 740.7 467.3 436.9 740.7 716.3 860.9	240.6 740.7 467.3 436.9 740.7 716.3 860.9	240.6 740.7 467.3 436.9 740.7 716.3 860.9
ommuni- ecraft PM slo TL PM nor TL ift status FM TV TL pla s time raft on of Js time rition) communi- ecraft PM mov PM slo	PM modes low LM PM modes or modes or modes TLM TM modes V LM LM Layback IV B	< B U O M < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U < B U												740.7 467.3 436.9 740.7 716.3	740.7 494.1 437.3 740.7 716.3 861.3	740.7 494.1 437.3 740.7 716.3 861.3	740.7 467.3 436.9 740.7 716.3 860.9	740.7 467.3 436.9 740.7 716.3 860.9	740.7 467.3 436.9 740.7 716.3 860.9
ommuni- ecraft PM slo TL PM nor TL ift status FM TV TL pla s time raft on of Js time rition) communi- ecraft PM mov PM slo	PM modes low LM PM modes or modes or modes TLM TM modes V LM LM Layback IV B	BUDW4BU4BU4BU4BU4B												436.9 740.7 716.3	494.1 437.3 740.7 716.3 861.3	494.1 437.3 740.7 716.3 861.3	467.3 436.9 740.7 716.3 860.9	467.3 436.9 740.7 716.3 860.9	467.3 436.9 740.7 716.3 860.9
oraft PM slo TL PM nor TL Ift status FM TV TL pla S 1' other craft on of Js time ition) ommuni- ecraft PM slo	PM modes low LM PM modes ormal LM TM rodes V LM Layback IV B	D												740.7 716.3	740.7 716.3 861.3	740.7 716.3 861.3	740.7 716.3 860.9	740.7 716.3 860.9	740.7 716.3 860.9
on of Jatime Ition) and or or of Jatime Ition) and or	PM modes low LM PM modes formal LM M modes V LM Layback IV B	世 4 8 C 4 8 C 4 8 C 4 8 C 4 B C 4 B C												716.3	716.3 861.3	716.3 861.3	716.3 860.9	716 3 860.9	716.3 860.9
on of Js time ition) and or or of Js time or of Js time ition) and or	low LM PM modes formal LM TLM TLM TLM TLM TLM TLM TLM TLM TLM	A B C A B C A B C A B C A B											-		861.3	861.3	860.9	860.9	860.9
on of Js time ition) and or or of Js time or of Js time ition) and or	low LM PM modes formal LM TLM TLM TLM TLM TLM TLM TLM TLM TLM	8 U A B U A B U A B U A B					10						-	000.7					
on of stime ition) ommuni-ecraft TL PM TV TL pla S t' other pM craft on of ys time ition) ommuni-ecraft PM slo	LM PM modes ormal LM TM modes V TLM Idayback IV B	O A B O A B O A B O A B					10					1	1 1	152.7	152.7				152.7
on of physilme right status on of physilme right on of physilme right on ordinary or	PM modes formal "LM "M modes "V "LM layback IV B	B C A B C A B C A B											-	239.4	239.4	239.4	239.4	239.4	239.4
other craft moderate ition) ommuni- ocraft PM rng dop ang ommuni- ocraft PM rng dop ang ommuni- ocraft PM pM rng dop ang ommuni- ocraft PM slo	*LM *M modes *V ** *LM *layback ** ** ** ** ** ** ** ** ** ** ** ** **	O A B O A B O A B											a armit apr	860.9	861.3	861.3	860.9	860.9	860.9
other craft modern on of Js time ition) and operate on of Js time on of	M modes V FLM layback IV B	A B C A B C A B									- Charles Springer			152.7	152.7	152.7	152.7	152.7	152.7
on of Js time right on of Js time recraft PM communication)	TLM layback	B C A B C A B					-				and .	 		239.4 860.9	239.4 861.3	239.4 861.3	239,4 860.9	239.4 860.9	239.4 860.9
on of Js time right on of Js time recraft PM communication)	TLM layback	C A B C A B							<u> </u>			 	 	152.7	152.7	152.7	152.7	152.7	152.7
on of PM rng dop ang or of PM slo	IV B	A B C A B						 		-		-		239.4	239.4	239.4	239.4	239.4	239.4
on of PM rng dop ang or of PM slo	IV B	C A B C A B												860.9	861.3	861.3	860.9	800.9	860.9
on of PM rug rison and on of PM rug rison Ang	IVB	A B C A B				_								152.7	152.7	152.7	152.7	152.7	152.7
on of PM rng dop ang on of PM silo	X	B C A B								-				239.4	239.4	239.4	239.4	239.4	239.4
on of PM rng dop ang on of PM silo	X	C A B										 	-	340.0 152.7	340.0 152.7	340.0 152.7	340.0 152.7	340.0 152.7	340.0 152.7
on of Js time rng dop ang PM moderaft PM slo		A B				_			 				-	239.4	239.4	239.4	239.4	239.4	239.4
on of Js time rng dop ang PM moderaft PM slo			- 1		_		-		 	 		<u> </u>		2111.4	213.4	213.4	213.4	213.4	213.4
on of Js time rng dop ang PM moderaft PM slo														227.0	229.0	213.4	229.0	229.0	229.0
on of Js time rng dop ang PM moderaft PM slo	244	C				_								1213.3	1213.8	1213.8	1213.3	1213.3	1213.3
on of PM rng dop ition) dop and PM communi- ecraft VH	nodes	D			_		-				 	ļ		203.3 346.3	293.3 348.9	293.3 348.9	293.3 346.3	293.3 346.3	293.3 346.3
Js time (right) dop (dop (dop (dop (dop (dop (dop (dop		F					+-		 			 		239.4	239.4	239.4	239.4	239.4	239.4
Js time (right) dop (dop (dop (dop (dop (dop (dop (dop		Ġ	2**		- 1	-	1			 		 	 	229.0	229.0	229.0	229.0	229.0	229.0
ommuni- ecraft PM slo	M	A	2**		3	5	* * 1:							318.0	318.0	318.0	318.0	318.0	316.0
ommuni- ecraft VH	nging	В												171.8	171.8	171.8	171.8	171.8	171.8
ommuni- ecraft VH	oppler	C			_]			<u></u>	 -	ļ		400.5	400.5	400.5	400.5	400.5	400.5
ecraft PM	ng le	Ď				_				 	<u> </u>	 		240.6 740.7	240.6 740.7	240.6 740.7	240.6 740.7	240.6 740.7	240.6 740.7
ecraft PM	м	B			-		+	{		 	 	 		467.3	494.1	494.1	467.3	467.3	467.3
ecraft VH	nodes,	č					1	 						436.9	437.3	437.3	436.9	436.9	436.9
slo	/HF	Ω												740.7	740.7	740.7	740.7	740.7	740.7
slo		E			_									716.3	716.3	716.3	716.3	716.3	716.3
	OM modes	A B								ONTI	NI IO	15		860.9 152.7	861.3 152.7	860.9 152.7	860.9 152.7	860.9 152.7	860.9 152.7
1 TL	LW L	문					 			-UN 11	NUUL	10		239.4	239.4	239.4	239.4	239.4	239.4
	M modes	Ā					上			COVE	RAG	Ę		860.9	861.3	861.3	860.9	860.9	860.9
	ormal	В												152.7	152.7	152.7	152.7	152.7	152.7
LTL	r <u>lm</u>	Ç				4-	1							239.4	239.4	239.4	239.4	239.4	239.4
oft status FM	-M modes	B						 				 -		860.9 152.7	861.3 152.7	861.3 152.7	860.9 152.7	860.9 152.7	860.9 152.7
TV		c					 	 		 	 	 		239.4	239.4	239.4	239.4	239.4	239.4
		Ä			_	1-	1			 	-			860.9	861.3	861.3	860.9	860.9	860.9
- I	rlm	В												152.7	152.7	152.7	152.7	152.7	152.7
pla	layback	C												239.4	239.4	239.4	239.4	239.4	239.4
۱		A			_		.}	ļ				 		340.0	340.0	340.0	340.0 152.7	340.0 152.7	340.0 152.7
SI	IV B	ВС					+				 	 		152.7 239.4	152.7 239.4	152.7 239.4	239.4	239.4	239.4
		A				-	-	 			 	 		213.4	213.4	213.4	213.4	213.4	213.4
1	I	B				1	1	 			 	 		229.0	229.0	229.0	229.0	229.0	229.0
/asha mi		c							······································					1213.3	1213.3	1213.3	1213.3	1213.3	1213.3
	714	D												293.3	293.3	293.3	293.3	293.3	293.3
moc	»M		ı				-	 		 	 -	<u> </u>		346.3	348.9	348.9 239.4	346.3 239.4	346.3 239.4	346.3 239.4
j	PM nodes	E			i		1 —				L	1		239.4	239.4	239.4	229.0	229.0	229.0

CIENCY) IS ASSUMED TO BE THE REQUIRED SUPPORT FUNCTION

TABLE IV LUNAR LANDING MISSION RELIABILITY NOMINAL OPERATING

Mission phose	Essential data/ major decisions	Duration of single site coverage interval	1	Required MSFN support fun	etions	10 22 M1	supportect to an anu	orting t with th	he fu	one site nation d according s while	od no: n <u>o</u> dt
(C) Translunar flight	(a) Abort and	Approximate 10 to 14 hrs on			PM	, A	8	51 i i i i		30' 2	85°
ii yai	(b) Lunar orbit insertion	10 to 14 hrs off** (Earths' Diurnal Rotation)	1	Determine position of spacecraft versus time (tracking/navigation)	rnging doppler angle	В С О					
			11	Maintain voice communication with spacecraft	PM modes, VHF	K B C D E					
				, in the second section of the second section	PM modes slow TLM PM modes	< □					
			111	Monitor spacecraft	normal TLM FM modes TV						2
				status and systems	TLM playback	∪ < <u></u> ω ∪				\gtrsim	12372
					\$ IV B			4		******** ******** 2	
			IV	date to spacecraft (e.g. transmit navigation up- dates, transmit midecurse guidance correction tar- acting, transmit targeting	modes	A B C C E					4
(D) Lunar	(a) Lunar orbit	a) Approximately	1	for possible aborts, transmit lunar orbit in section targeting) Determine position of	PM rnging	F G A B	2			3	5
orbit	determination (b) Lunar module descent & land.	1.3 hours on, 0.8 hours off for CSM	_	spacecraft versus time (tracking/navigation)	doppler angle	D A					
	ing (c) Lunar module	b) Approximately 12 to 14 hours for LM**	11	Maintain voice communication with spacecraft	MM modes, VHF	8 C D W					
	(c) Lunar module stay (d) Lunar module ascent & rendezvous				PM modes slow TLM PM modes	B C A					
	, and a second			Monitor spacecraft status and systems (e.g. verify AGC state vector following lunar orbit insertion	normal TLM FM modes TV	B C A B C				$\stackrel{\downarrow}{<}$	
				eran magnion	TLM playback	A B C		8 8888			
			IV	Send commands/other	SIVA	⊗ € ⊗© A				3	
				up data to a spacecraft (e.g. transmit targeting for lunar orbit insertion 2nd burn, transmit navi-	PM modes	BCDE					
				gation updates, transmit targeting for transearth injection)		F	-	-	1	1	-

^{*}AS DEFINED IN THE MSFN SUPPORT FUNCTION LIST FIG. 1

**DURNING "OFF" PERIODS FUNCTION V (MAINTAIN SITE PROFICIENCY) IS ASSUMED TO BE THE REQUIRED S

**INCLUDES WING SITE

TABLE IV-2
* NOMINAL OPERATING PARAMETERS FOR MSFN AND SPACECRAFT (cont'd)

ctions	of co	suppo ntact	eting t with th	ha fur le spo	etie enc netion c necrost s which	on be the m	in ini•	no si	te cap	oble (rval d	erting					mation for th		
		conta		S 110)	s which	n can	1) (2	ioneii	en co	10017	conta	CI	*****	One sp	ocecroli 5 = D =	Single Dual	Two sp	acecraft S -	Single Dual
	*	85	1	3	101	85' 0	7 30	85		3()'	85° c	r 30'	301-ან	30'⊸D	851	30+≈5	30'≂D	851
PM	A	2*		AN TON LANGUAGE	2	4*	† ¢				1000			318 U	318.0	3180	3180	318.0	118 0
rnging doppler	G G	The state of the state of	dimini pieto.	*************	-5000100007	KOODIA PARADO			areas age-	estrones (-	CHICAL SCHOOL	ence (Allerines) zo	cia/esa tinto	171.8 400.5	180.4 400.5	180 4 " 400.5	171 8	171.8 400.5	171 8 400 5
angle	ठ	ATTENDED OF	-0 ATT. DOC.				ex.::::::::::	·			STATE OF THE PARTY.	***************************************	******	240.6	240 6	240 6	240 6	240.6	240 6
	"A"	THE COLUMN	THE RESIDENT	Total Lineary		THE PERSON	**************************************		1910 TOOKST.)	न्त्रसः इतस्यक्ताम्बर	entransistati	MEDICAL PROPERTY.	A PROTECTION AND ADDRESS OF THE PARTY.	740.7	740.7	740.7	740.7	740.7	740.7
PM	ß		******	राम्ब्राम्बर्ग स	BEAU TELE-	- ALCOHOLD		COMMITTEE AND		***	citore establishe	and the same of	COMMITTED ST	467.3	494	494	467.3	467.3	467.3
modes, VHP	0	***********	**************************************	**********	escitation of		W-2	-			***************************************	ALEKE TOTAL	COURSE 4	436.9 740.7	437.3 740.7	437.3 740.7	436.9 740.7	436.9 740.7	435.9 740.7
****	E	-polari angkisyaty	N ORMAN CONTRACTOR	- Wireline Western	rapide strategical	militir rezistania	ni spozija Aprilavini	mai polenja vireli jirini (bizz		- collected and the	etrest orizaco	CONTRACTOR OF THE		716.3	716.3	716.3	716.3	716.3	716.3
I'M modes	A	1000 JUCC 100				ALTERNATIONS AND ADDRESS OF THE PERSON ADDRESS OF THE PERSON AND ADDRESS OF THE PERSON ADDRESS OF THE PERSON AND ADDRESS OF THE PERSON ADDRESS OF THE PERSON AND ADDRESS OF THE PERSON ADDRESS OF THE PE	AND THE PERSON NAMED IN				ACTOR RESISTANCE			860.9	861 J	P61.3	860.9	860 9	860.9
slow	6	30777	weeking his characters		******					======		стоинского		152.7 239.4	1 <i>52.7</i> 239.4	152.7 239.4	152 7 239.4	152.7 239.4	152.7 239.4
T L.M PM modes	C X	********		****	Mark Street	*#*********	1000 to 200 (100 at 100 at		nint, ciramen.	-		TANKE IN	JUNE 23 - 29 M	860.9	861.3	861 3	860.9	237.4 860.9	860 9
normal	B	- The same	and the state of the state of		- PERSONAL TERM	***	MARCO STOP	- AND DESCRIPTION OF THE	C	NTIN	เบอบเ	S		152.7	152.7	152.7	152.7	152.7	152.7
TLM	C	PACTO SECURIORISM			L.	CLI ISSUERE								239.4	239.4	239 4	239.4	239.4	239 4
FM modes	A	120-100-100-100-100-100-100-100-100-100-			/	2*	* *	entrapional intel	(OVE	RAGE		(860.9	861.3 152.7	861.3	860.7	860.9 152.7	860.9
TV	oω				<u> </u>	CUI ET PRIM	********				A-2007/81/3 (2016) 2000	-	Commercial	152.7 239.4	239.4	152.7 239.4	152.7 239.4	152.7 239.4	152.7 239.4
	Ä				>	-stimentone	****	*****	MATERIAL MATERIAL PROPERTY AND ADDRESS OF THE PARTY AND ADDRESS OF THE	-		OMPRESSOR CO.	200220087200	860.9	861.3	861.3	860.9	860 9	860 9
TLM playback	В		40 MP (1200 MA)	-	\mathbf{X}_{-}						**********			152.7	152.7	152.7	152.7	152.7	152.7
proyouck	30	*****				******		**********			*****			239.4	239.4	237.4	239.4	239.4	239.4
SIVB	B	*****	44444	*****	****	******	******	******	*******	******				ليعرفنه والمتعرفية			******	*************	***********
4,,,	C	******		******	*****		*****		*******	******	*******		*******		*********		1411411414141	************	14444
	A				2	4.	* *							213.4	213.4	213.4	213.4	213.4	213.4
	B C	al - Berteinie						elektiya yak	-		inippoint.	***	in colorant sincini)	229.0 1213.3	229.0 1213.3	229.0 1213.3	229.0 1213.3	229.0 1213.3	229.0 1213.3
PM	ठ				*******	-	**********	COLUMN SKITTLE	Tananaa-	esecutivaes		THE REAL PROPERTY.	a constant	293.3	293.3	293.3	293.3	293.3	293.3
modes	E		- ALLENS OF THE CASE		CONTRACTOR DE	THE RESERVE		THE PARTY OF THE P	marie di Assista	-27-1-12-1-12-1-1-1-1-1	w. Commission 30-	enterior però destra	tania distribution	346.3	348.9	348.9	346.3	346.3	346.3
	F		-	-	- AND CONTRACT CONTRA	tg danstranis	********	ACCUSATION AND AND AND AND AND AND ADDRESS OF THE PERSON AND ADDRESS O		A Minimization	****		andreas parties	239.4	237.4	239.4	239.4	239.4	239.4
PM	G A	2.	* *		<u>† </u>	5*		48 min	(C'SM)	48 mir	VCSM)	48 mir	VCSM)	229.0 318.0	229.0 318.0	229.0 318.0	229.0 318.0	229.0 318.0	229 0 318.0
rnging	ß			ļ	<u> </u>		·····	4011111	(COIN)	4011111	1.650111)	4011111	100111	171.8	180.4	180.4	171.8	171.8	171.8
doppler	C							-	and Secretary Company	###() MEX 800. St. Ac.	esituide situic kin	***********	- derik yank saram-	400.5	400.5	400.5	400.5	400.5	400.5
angle	D	-E thicked here	-		THE RESERVE	-def Attack and a life	araken ann an	acys in a least to	-		accinistrative chiefs co-	THE PERSON NAMED IN	CORPORED TO THE OWNER.	240.6	240.6	240.6	240.6	240.6	240.6
РМ	В					ORNERO MICELO	Antendata's	**************************************	*****	and the same	*COLUMN STATES	ric stressormania	****	740.7 467.3	740.7 494.1	740.7 494.1	740.7 467.3	740.7 467.3	740.7 467.3
modes,	Ċ		MOKETY MERCHANI		*******	-	*******		- Vertical Participat	Construction				436.9	437.3	437.3	436.9	436.9	436.9
VHF	D	**********			- named ir samblicas	with all places as	Angal mitraer sti-	a de populación de la constitución	Chiant Ciana	e e ration	in and the second secon		AND HAVE SEE	740.7	740.7	740.7	740.7	740.7	740.7
Charles and the first seed of the	E		-		many use article sign	1250000000	60 (C)(C)(000000-0-	- Darkinson Darke	water (Char		and the street out to			716.3	716.3	716.3	716.3	716.3	716.3
PM modes	B						<u></u>				+			860.9 152.7	861.3 152.7	861.3 152.7	860.9 152.7	860.9 152.7	860.9 152.7
slow TLM	<u>c</u>			43. Principe		-	***********		al aba dalam sia		***********	*******		239.4	239.4	239.4	239.4	239.4	239.4
PM modes	A	action to											***************************************	860.9	861.3	861.3	860.9	860.9	86C.9
normal	B					-			Carle and his		-	4174-1-1-1-1	**********	152.7	152.7	152.7	152.7	152,7	152.7
TLM	> ∩	- Period	4 M (2 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -		<u> </u>	2+	**			ļ				239.4 860.9	239.4 861.3	239.4 861.3	239.4 860.9	239.4 860.9	239.4 860.9
FM modes	B				X			****					-	152.7	152.7	152.7	152.7	152.7	152.7
TV	C			Z	\sim									239.4	239.4	239.4	239.4	239.4	239.4
TLM	A			>	/	ļ		 						860.9 152.7	861.3 152.7	861.3 152.7	860.9 152.7	860.9 152.7	860.9 152.7
playback	ВС				\sim				-					239.4	239.4	239.4	239.4	239.4	239.4
SIVA	86. J																		
	Ç	(1868) 1			3	5360000 5 *	* *							213.4	213.4	213,4	213.4	213.4	213.4
	B				<u> </u>		r a operado (**					 	 	326.0	226.0	226.0	226.0	226.0	226.0
,	Ċ													1213.3	1213.3	1213.3	1213.3	1213.3	1213.3
PM modes	D				ļ									293,3	293.3	293.3	293.3	293.3	293.3
Mones	E F			<u> </u>						 			 	346.3 239.4	348.9 239.4	348.9 239.4	346.3 239.4	346.3 239.4	346.3 239.4
	C												 	229.0	229.0	229.0	229.0	229.0	229.0
		L	<u></u>	L	Y	<u> </u>	L	·	<u> </u>	<u> </u>	L	·	I	l,	L.,,	l	L.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	I	L

IS ASSUMED TO BE THE REQUIRED SUPPORT FUNCTION

TABLE IV-: LUNAR LANDING MISSION RELIABILITY NOMINAL OPERATING

(E) Transearth flight	(a) Trensearth Injection (b) Earths' atmosphere entry	Approximate 10 to 14 livs on 10 to 14 livs off**		Determine position of spacecraft versus time (tracking inevigation) Maintain vaice communication with spacecraft	PM modes slow TLM	C			3(85° 4°	3
flight	(b) Earths* atmosphere		11	spacecraft versus time (tracking navigation) Maintain vaice communi-	rnging deppler angle PM modes, VHF PM modes slow TLM	田でつく田でしまく 田で	2.		2			
	atmosphere	10 to 14 hrs off**		spacecraft versus time (tracking navigation) Maintain vaice communi-	PM modes, VHF PM modes slow	C D K B C D E K B C						
	atmosphere			Maintain vaice communis	PM modes, VHF PM modes slew							
					PM modes, VHF PM modes slew TLM							
	entry				modes, VHI ^E PM modes slow TLM							**************************************
					modes, VHI ^E PM modes slow TLM	OP WARD				*****		-
			111	cation with spacecroft	PM modes slow TLM					** ***********************************		1
			III	and well-defined control of the Parish of th	PM modes slow TLM	世人間で				* ***	**************************************	1
			111		slow TLM	AB C				* ***	· Security and Sec	-
			111		TLM	C		American State		1	1	
			111								- Apple 2 marks	
			111							-		
			111		PM modes		-	20.000	******			-
		·	""		nermal	В	-		-	-	***************************************	
			1	Monitor spacecraft status	and in ability of the plant	Ç			_		7.	ļ.,
			1	and systems (e.g. verify AGC state	FM modes				1	Z		1
				vector following trans-	TV	Č	 			and the same	******* *****************************	r Proper
		B .		earth injection)	TLM	一方	-					-
						В	A CONTRACTOR	7.0.01.00.00		X		
					PINTEN					\overline{z}		
					send commands other up at a to spacecraft ag, transmit tergeting or entry corridor part of pacecraft versus time racking navigation of pacecraft versus time racking navigation of ag, entry trajectory onitoring, splash point rediction) alintain voice community modes.		*****	 				
					5 IV B	A 2 B C C C C C C C C C C C C C C C C C C C	******					
			_					* * *				
			1	Send commands other up data to spacecraft (e.g. transmit targeting for entry carridor control) Determine position of spacecraft versus time (tracking/navigation) (e.g. entry trajectory monitoring, splash point prediction) Maintain voice communication with spacecraft PM	{	- 4	1					
			IV Send commands other up data to spacecraft (e.g. transmit tergeting for entry corridor control) Approximate I Determine position of spacecraft versus time (tracking navigation) (e.g. entry trajectory monitoring, splash point prediction) II Maintain voice communication with spacecraft II Maintain voice communication with spacecraft wit	-	 		-					
					-	-		****				
		*			-							
				-								
		Approximate I De 10 minutes (r. 6. mo pre		<u> </u>			Į.		<u> </u>		1	
F) Entry			1							1	<u> </u>	<u> </u>
		10 minutes	1	(tracking/navigation)				-				-
		Approximate 10 minutes Determine position of spacecraft versus time (tracking/navigation) (e.g. entry trajectory monitoring, splash point prediction) Maintain voice communication with spacecraft PM modes, VHF					-		-			
			,	monitoring, splash point	00016		-	deliga ega				╫
			-	prediction)	- PM		-	(************************************	-	-	- cardosini	-
			11	Maintain voice communi-			 	·	-	 	-	+
								***********	-		1	1
		spacecraft versus time (tracking/navigation) (e.g. entry trajectory monitoring, splash point prediction) Il Maintain voice communication with spacecraft PM slot TL PM nor			E						I	
				A						L		
			spacecraft versus time (tracking navigation) (e.g. entry trajectory monitoring, splash point prediction) II Maintain voice communication with spacecraft PM modes, VHF D PM modes A slow B TLM C PM modes A normal B TLM C									
		1		-		-	-					
					cking/navigation) . entry trajectory itering, splash point liction) A PM modes, VHF D PM modes, Siow TLM C PM modes A Incrmal B TLM A	 		+-				
				prediction) II Maintain voice communication with spacecraft PM modes, C VHF D D E E PM modes A Slow B TLM C PM modes A normal B TLM C A		-	-	╁				
			II Maintain voice communication with spacecraft PM modes slow TLM PM modes normal TLM III Monitor spacecraft status FM modes	A	-	···	-	-		-		
		PM modes A slow B TLM C PM modes A normal TLM C PM modes A normal TLM C TLM C TLM C TLM C TLM C TLM C TLM A B TV C TLM B			1		1	1	1	-		
			and systems	TV	C	1						
					1		1					
			I		2010000000000000			2010195652	2 222222	2550000	0000000	
		1							1			+
			1		7.14					1	+	Ħ,
			-				crossess	5600000	2000000	100000	*******	4
						В	1		1		1	1
	III Monitor spacecraft status and systems III Monitor spacecraft status and systems FM modes B TV		1		 	Ċ			1	I		T
•			١٧						1			
-					\perp							
		(fracking navigation) (e.g. entry trajectory monitoring, splash point prediction) II Maintain voice communication with spacecraft III Monitor spacecraft status and systems IV Send commands other C	<u> </u>		\pm							

^{*}AS DEFINED IN THE MSFN SUPPORT FUNCTION LIST FIG. 1

**DURING "OFF" PERIODS FUNCTION V (MAINTAIN SITE PROFICIENCY) IS ASSUMED TO BE THE REQUIRED SUPP

***INCLUDES WING SITE

TABLE IV-3
BILITY NOMINAL OPERATING PARAMETERS FOR MSFN AND SPACECRAFT (cont'd)

epport fu	nctions	l of	SUPD	ortina	the fu	ene sit nction recret	con be	in	no sile ce	pable	of sup			Single sit	• MTBF ••I	metion for th	e function	
- ppm - 101		m		mbet ö		which			function co				One spe	regeralt 5 = 1		Two spe	cecieli 5 = D =	Single Dual
	РМ	,		35'	3	0'	85'	or 30'	85'		<u> </u>	85' or 30'	30'-5	30'=D	85'	30'-5	30' D	85'
n of	rnging	<u> </u>	2	***		2	4*	7		CONTRACTOR OF	-	L	318.0	3180	3180	316.0	3180	318.0
s time	doppler	Ţ	-	-	7774				. و بدر مستونین	= = = =		ren - retired County	171.8	186.4 400.5	180 4 400 5	400.5	7718	171.8 400.5
tion)	angle	o U	· Contract	-			 		and compare compared to the special property of the sp	•			240.6	240 6	240 6	240.6	240.6	240.6
3		¥			-			 		-	k====		740 7	740.7	740.7	740 7	740.7	740 7
	PM	B	****	-	or a continuent	ediament)	eneme:			-			467 3	474.1	494	467.3	467.1	467.3
ាមមក្សារ	modes,	Č	Michael Company				†	**********	endaggada eta en arez e				436 9	437.3	437 3	4'16.9	436.9	436.9
ecroft	YHP '	D	WW. Second		- House and	- AMERICAN STREET							740.7	740.7	740.7	740 7	740.7	740.7
	T TOTAL CONTRACT	E	-			-		-		-	and the last		716.3	716.3	716.3	716.3	716.3	716.3
	PM modes	^	-120404	ļ					· market kanadari ya s	2 0000	-		860.9 152.7	861.3 152.7	861.3 152.7	860.9 152.7	860.9 152.7	860.9 152.7
	slow TLM	-6	West Street	MORE CARD	ristr aine e	-		COLUMN TO A		-	es pressec		239.4	239.4	239.4	239.4	239.4	239.4
	PM modes		# I R Production	-	-			 	CUMIC SERVICE.	20 CB 1 THE			860.9	861.3	8613	860.0	860.9	760.9
	normal	В			1		-	THE STATE OF		CONT	IOUNI	JS.	152.7	152.7	152.7	152.7	152.7	152.7
alt status	TLM	C	7.32			1	I man				Trining's	I	239.4	239.4	239.4	2:19.4	239.4	239.4
	PM modes	ΛB	***************************************	400000000000000000000000000000000000000			2.	7		COVE	RAGI	Table this see	860.9	861.3	861.3	860.9	860.9	850.9
state	TV	_ <u></u>	-	ļ		X (122	-	owen project			ļ		152.7	152.7	152.7 237.4	152.7 239 4	152.7 239.4	152.7 239.4
trans-	****	<u>5</u>	-21JR gw	2 Printers 6-361	K		- KONCONDO	C2153223			-		239.4 860.9	239.4 661.3	237.4 861.3	239 A 860 9	860.9	860.9
	TLM	Ĥ		-				AND SHOWING SERVICE	40.500 minutes (1.500 minutes)	****	ent with real		152.7	152.7	152.7	152.7	152.7	152.7
	playback	BC		-	17	-/-	****	*****	********	-	* ====		239.4	239.4	239.4	239.4	239.4	239.4
	***************************************	X				******		A	***************************************			and the section 14				*****		************
	SIYB	8			$\mathbf{F}_{\mathbf{m}}$												-	
· Practice with the contract of the contract o														سيسيبين	-	*******		
- 41 a		<u>A</u>		-	-	2 *********	4.	Louiseus de Le R		ED -008323000	-		213.4	213.4 229.0	213.4 229.0	213.4 229.0	213.4 229.0	213.4 229.0
other up		2	***				10.50x	**********		-	a promisera		229.0 1213.3	1213.3	1213.3	1213.3	1213.3	1213.3
 ∘geting	PM	6		-	-	- Christian in the	micromatica (WEST TRANSPORTED			COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED IN COLUMN TO SERVICE STATE OF THE PERSON NAMED STATE OF THE PERSON NAMED STATE OF THE PERSON NAMED STATE OF TH	-	293.3	293.3	293.3	293.3	293.3	293.3
· *	modes	E			-	**********		-	CARLOS AND SHAPE SACREDES		111111111111111111111111111111111111111	20120222	346.3	348.9	343.9	346.3	346.3	346.3
		F	-							A ALTERNATION			239.4	239.4	239.4	239.4	239.4	239.4
	e Zanie i za za za zanie	Ğ	- CHICATOR NA	İ.,		İ	-			23	ŧ.	A POST TO MAKE AND AND AND	229,0	229.0	229.0	229.0	229.0	229.0
ion of J≸ time	PM	Â	-		-]	ecitorium.	 		1 3	min	3 min	318.0	∃18.0 180.4	310.0 180.4	318.0 171.8	318.0 171.8	318.0 171.8
ition)	rnging doppler	<u> </u>	*******	entre personie			-			****	WORKS TO MAKE		171.8 400.5	400.5	400.5	40G.5	400.5	400.5
etory sh point	angle	Ď		-	-		***************************************	-	***		AND STREET		240.6	240.6	240.6	240.6	240.6	240.6
wir boun		A			TO COLUMN TO SERVICE	**************************************		4000	CATALOGRAPHICA COMPANIAN C		and the state of	-	740.7	740.7	740.7	740.7	740.7	746.7
omnuni.	PM	В				MALE BALLOW	CENTRA ENGINE		opposite the state of the state				467.3	494.1	494.1	467.3	467.3	467.3
cacraí+	modes,	C								****			436.9	437.3	437.3	436.9	436.9	436.9
	VHF	D	**********						***********				740.7	740.7 716.3	740.7 716.3	740.7 716.3	740.7 716.3	740.7 716.3
	PM modes	A		-	-	-	Ste Percences	ect Michigan Co.	- AND AND AND AND AND AND AND AND AND AND	- FREINING	100007-012-000-00	- CORCUMINO ASSESSMEN	716.3 860.9	861.3	861.3	50U.9	860.9	860.9
	# low	B			-	-				*	-		152.7	152.7	152.7	152.7	152.7	152.7
	TLM	C			1	-	***********		-		-		239.4	239.4	239.4	239.4	239.4	239.4
ĺ	PM modes						AMERICA NO.	1					860.9	861.3	861.3	860.9	860.9	860.9
	normal	0				.)						,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	152.7	152.7	152.7	152.7	152.7	152.7
	TLM	× 0					ļ			_		ļ	239.4	239.4	239.4 861.3	239.4	239.4 860.9	239.4 860.9
aft status	FM modes	B			****	-	 						860.9 152.7	£61.3 152.7	152.7	860.9 152.7	152.7	152.7
	TV	Ċ			1	1	 					-	239.4	239.4	239,4	239.4	239.4	239,4
	TLM	A			1					-		 	860.9	861.3	861.3	860.9	860.9	860.9
	playback	В			-								152.7	152.7	152.7	152.7	152.7	152.7
	7772.00	Ç	Contract		200000			70,000		2, 22, 22, 22	300000		239.4	239.4	239.4	239.4	239.4	239.4
	SIVA	88.38 81.38			1	 					!	 		1		 		ļ
	7.7				+	! ····-	•		}		; ,,,,,	 	· 		•	 		
		Ā	neriiii		The second	نتنتنتن	*******	and the		4	<i>ۯڔڟؿڟؿڣڎ</i>		213.4	213.4	213.4	213.4	213.4	213.4
		В									THE PERSON NAMED IN		229.0	229.0	229.0	229.0	229.0	229.0
حداده	PM	C											1213.3	1213.3	1213.5	1213.3	1213.3	1213.3
other craft	modes	D	<u> </u>		-					-			293.3	293.3	293.3	293.3	293.3	293.3
-1911	111 AND A	<u> </u>				ļ		ļ,			ļ		346.3	348.9	348.9	346.3	346.3	346.3
		-5		المسيطين سني	 			-				 	239.4	239.4	239.4	239.4	239.4	239.4 229.0
		, v	١.		1	<u>L</u>	L!	I	l		1	i	229.0	229.0	229.0	229.0	229.0	447.0

CIENCY) IS ASSUMED TO BE THE REQUIRED SUPPORT FUNCTION

TABLE IV-4
LUNAR LANDING MISSION RELIABILITY NOMINAL OPERATING FARAMETERS FOR

Mission phase	Essential data/ major decisions	Duration of single site	Required MSFN support func	tions		·	over i	nole
pilova	1110 01 5551210113	coverage interval			ļ.,	ne spacecr	alt D - D	vál
	4			1	<u> '</u> -	30'-5	30'-D	
A) Launch,	(a) Earth orbit	Appreximate	f Determine position of	PM	A	.99953	.99953	.99
insertion,	determination	8 min on	spacecraft versus time	tuajna	В	.99934	.92934	.99
Earth orbit	// \ 7"	80 min off**	(tracking/navigation)	doppler	C D	.99967 .99945	,99967 ,99945	.99
	(b) Translunar	(typical Earth orbit coverage)		angle	 -	.99984	.99984	1.9
	go/no go	Omit Cove age/		PM	B	.99984		
			Il Maintain voice communication	modes,	C	.99984		
			with spacecraft	VHF	D	.99984		_
				<u> </u>	E	.99984	00000	┯,
				PM modes slow	B	.99983	.99983	-9
				TLM	T	.99945	99945	.9
				PM modes	A	.99983	.99983	.9
				normai	B	.99913	.99913	1.5
			III Monitor spacecraft status	TL.M	C	.99945	.99945	
) 1		and systems	FM modes	B	,99913	.99913	+
				TV	C .	.99945	.99945	+:
	1			TLM	A	.99983	.99983	7.9
				playback	В	.99913	,99913	
				F7	Ç	.99945	.99945 .99960	1
				SIVB	AB	.99913	.99913	+:
				317.6	C	.99945	.99945	1-:
				-	A	,99938	.99938	
				į.	В	.99942	.99942	
			IV Send commands/other	PM	CD	.99981	.99981 .99955	+
			up data to spacecraft	modes	E	.99975	.99975	+:
		·			F	.99945	,99945	Ţ,
					G	.99942	.99942	<u> </u>
) SIV B	(a) Lunar	Approximate	Determine position of	PM.	A	.99313	.99313	1.
Separation, transposition	landing determination	120 min	spacecraft versus time	rnging doppler	B C	.98911 .99522	.98911 .99522	-
and docking	milestone		(tracking/navigation)	angle	<u>D</u>	.99192	.99192	†:
atter acoustifA	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,			1	A	.99880	,99880	١.
			Il Maintain voice communication	PM	В	.99769	.99769	1.
		!	with spacecraft	modes, VHF	C	.99769	.99769	<u>:</u>
		1	,	VIII.	붙	.99769	.99769	+:
				PM modes	Ā	.99768	.99768	Τ.
				slow	В	.98717	,98717	1
				TLM	Č	.09188	.99188	
		ļ		PM modes normal	B	.99769	.99769 .98717	-
		1	III Monitor spacecraft status	TLM	C	.99188	.99188	+:
			and systems	FM modes	A	.99769	.99769	Ţ.
				TV modes	В	.98717	.98717	
			Į		Ç	.99188 .99769	.99188	+
				TLM	B	.98717	.99769 .98717	+:
				playback	C	.99188	,99188	+
			1		A	.99404	.99404	Ι,
				SIVB	В	.98717	.98717	
		·			Ç.	.99188	.99188	
					B	.99087	.99087	+
			1		c	.99273	.99273	+
			IV Send communds/other	PM	D	.99320	.99320	Ι.
			up data to spacecraft	modes	E	.99652	.99652	
			· ·	ļ	I F	.99188	.99188	
		1	1		G	.99151	.99151	

^{*}AS DEFINED IN THE MSFN SUPPORT FUNCTION LIST FIG. 1

^{**}DURING "OFF" PERIODS FUNCTION V (MAINTAIN SITE PROFICIENCY) IS ASSUMED TO BE THE REQUIRED SUPPORT FUNCTION.

TABLE IV-4 ABILITY NOMINAL OPERATING PARAMETERS FOR MSFN AND SPACECRAFT (cont'd)

ation of				Overall reliability ov the coverage interva (multiple sites)								
gle site ge interval	Required MSFN support functions			ne spaceci	\$ - \$1 oft D - D	ngle val	Two spo	S scecraft D	- Single - Dual	One space-	Two space-	
			*	30'\$	30'-D	851	30'-S	30'-D	854	craft	craft	
imate	Determine position of	PM	A	.99953	.99953	,99953	.99953	.99953	.999953	.999953	1	
n	spacecraft versus time	rnging	В	.99934	,99934	.99934	.99934	.99934	.99934	,99934		
off**	(tracking/navigation)	doppler	C	.99967	.99957	.99967	.99967	.99967	.99967	.99967		
Earth		ongle	D	.99945	.99945	.99945	.99945	,99945	.99945	.99945		
verage)		211	A	.99984	.99984	,99984	.99984	.99984	.99984	.99984		
	Il Maintain voice communication	PM modes,	ВС	.99984								
	with spacecraft	VHF	片	.99984	 -	 	 	<u> </u>				
	İ	1 ''''	E	.99984		 	<u> </u>	 		<u> </u>	-\/	
		PM modes	TA	.99983	.99983	.99983	.99983	,99983	.99983	99983	 	
		slow	В	.99913	.99913	.99913	.99913	.99913	.99913	.99913		
		TLM	C	.99945	,99745	.99945	.99945	.99945	,99945	,99945		
		PM modes	A	.99983	.99783	.99983	.99983	.99983	.99983	.99983		
	1	normal	B	.99913	.99913	.99913	,99913	.99913	.99913	.99913		
	III Monitor spacecraft status	TLM	CA	.99945	.99945 .99983	.99945	.99945	.99945	.99945	.99945 .99983	 	
	and systems	FM modes	B	.99913	,99913	.99913	.99913	.99913	.99913	.99913	 Λ	
	ļ	TV	 <u> </u>	.99945	.99945	199945	.99945	.99945	.99945	.99945	 	
			Ā	.99983	,99983	,99983	.99983	.99983	,99983	.99983		
		TLM playback	В	.99913	,99913	.99913	.99913	.99913	.99913	.99913	11	
			C	.99945	.99945	.99945	.99945	.99945	.99945	.99945		
			A	.99960	.99960	,99960	.99960	.99960	.99960	.99960		
		\$ IV B	B	.99913	.99913	.99913	,99913	.99913	.99913	.99913	1	
			Ç	.99945	.99945	.99945	.99945	.99945	.99945	,99945	 _/	
	j	PM modes	A	,99938	.99938	.99938	.99938	.99938	.99938	.99938	_/	
			B	.99942	.99942 .99981	.99942	.99942 .99981	,99942 ,99981	,99942 ,99981	.99942	 - 	
	IV Send commands/other		10	.99955	.99955	.99955	.99955	199955	.99955	.99955	 - 	
	up data to spacecraft		E	.99975	.99975	199975	.99975	.9997.5	.99975	.99975	 	
			 	.99945	.99945	.99945	.99945	.99945	99945	.99945	 	
	3		G	,99942	.99942	.99942	.99942	.97942	.99942	.99942		
mate	I Data-da- accident of	PM	Α	.99313	,99313	.99313	.99313	.99313	.99313	.9999994	.9999	
	Determine position of spacecraft versus time	rnging doppler	В	.98911	98911،	,98911	.98911	.98911	.98911		.99987	
	(tracking/navigation)		C	.99522	,99522	.99522	,99522	,99522	.99522	<u> </u>	,99998	
	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	angle	P	.99192	.99192	,99192 ,99880	,99192 ,99880	.99192	,99192 ,99880	 	.99993	
	Il Maintain voice communication with spacecraft	PM modes, VHF	B	.99769	.99880 .99769	.99769	,99769	,99769	.99769	 	.99229	
			10	.99769	,99769	.99769	.99769	,99769	.99769	 	.9999	
			D	.99880	.99880	.99880	.99880	.99880	.99880		.99999	
			E	.99769	.99769	.99769	.99769	.99769	.99769		,99999	
		PM modes	Α	.99768	.99768	.99768	.99768	,99768	.99768		.99999	
		slow	В	,98717	.98717	,98717	.98717	.98717	,98717		.99984	
		TLM PM modes	Š	.99188	.99188	.99188	.99188	.99188	.99188 .99769		.9999	
		normal	B	.99769 .98717	.99769 .98717	.99769 .98717	.98717	.98717	.98717		.99984	
	III Monitor spacecraft status	TLM	분	.99188	.99188	.99188	.99188	.99188	.99188	 	.9999	
	and systems		T A	.99769	.99769	199769	.99769	.99769	,99769		.9999	
		FM modes	В	78717	.98717	.98717	.98717	.98717	,98717		,9998	
		LY	С	.99188	.99188	,99188	,99188	.99188	.99188		.9999	
		TLM	A	.99769	.99769	.99769	.99769	,99769	.99769		.9999	
	1	playback	В	.98717	.98717	,98717	.98717	.98717	.98717 .99188		,9998,	
	i e	-	C A	.99188 .99404	.99188	.99188	.99188 .99404	.99188	.99404	.999989	.9999	
		SIVB	B	.98717	.99404 .98717	.98717	.98717	.98717	.98717	.999999+	.9998	
			C	.99188	.99188	.99168	.99188	.99188	.99188	1	.9999	
		1	Ä	.99087	.99087	.99087	.99087	.99087	,99087		.9999	
			В	.99151	.99151	.99151	.99151	.99151	.99151		.9999	
	1V \$4	1014	C	.99273	.99273	.99273	.99273	.99273	.99273		,9999	
	IV Send commands/other up data to spacecraft	PM modes	D	.99320	.99320	,99320	.99320	.99320	,99320		,9999	
	op data to spacecraft	modes	E	.99652	.99652	.99652	.99652	.99652	.99652	<u> </u>	.9999	
		[·	F	.99188	.99188	.99188	.99188 .99151	.99188	.99188		.9999	
	I		l G	.99151	.99151	,99151	. 00151					

TTE PROFICIENCY) IS ASSUMED TO BE THE REQUIRED SUPPORT FUNCTION.

TABLE IV-5
LUNAR LANDING MISSION RELIABILITY NOMINAL OPERATING PARAMETERS FOR

Mission	Essential data/	Duration of single site		Required MSFN support functi	ons	Single site over the cove \$ - Single					
phase	majo; decisions	coverage interval						craft [1 - [
						*	30'-S	30'-D	851		
(C) Translunar flight	(a) Abort and return	Approximate 10 to 14 hrs on 10 to 14 hrs off**	1	Determine position of spacecraft versus time	PM rnging doppler	A B C	.95247 .92645 .96708	.95247 .92645 .96708	.9524 .9264 .9670		
	(b) Lunar	(Earths' Diurnal		(tracking/navigation)	angle	Ď	.94486	.94486	.9448		
	orbit insertion	Rotation)	11	Maintain voice communication with spacecraft	PM modes,	B C	.98402 .98367 .98347	.98402 .98367 .98347	.9840 .9836 .9834		
	†			with spacecraft	VHF	m O	,98402 ,98402	,98402 ,98402	.9840 .9840		
			-		PM modes	Α	,98395	.98395	.9839		
					slow TLM	ВС	.91376 .94459	.91376 .94459	.9137		
					PM modes	A	.98395	.98395	.9839		
			Ш	• • • • • • • • • • • • • • • • • • • •	normal TLM	вС	.91376 .94459	.91376	.9137		
	 			and systems	FM modes	A	7		.9839		
					TV	C	-/		.9445		
					TLM	A B	_/	7	.9839		
					playback	c			.9445		
					5178						
			<u> </u>	6 1 1 / 1		®€® A	.93788	.93788	.9378		
				V Send commands/other up data to spacecraft (e.g. transmit	PM modes	B	.93013	.93013	.930		
				navigation updates, transmit midcourse guidance correction		CD	.98027	.98027 .95338	.9802 .9533		
				targeting, transmit targeting for		E	.97559	.97559	.975		
				possible aborts, transmit lunar orbit in section targeting)		F G	.93695	.93695 .93013	.9369		
(D) Lunar	(a) Lunar orbit determination (b) Lunar module descent & landing (c) Lunar module stay	a) Approximately 1.3 hours on, 0.8 hours off 107 CSM b) Approximately	1	Determine position of	PM	A	.95247	,95247	.9524		
orbit			}	spacecraft versus time	rnging doppler	С	.92645	.92645 .96708	.926		
			_	(tracking/navigation)	angle	D	.94486	.94436	.944		
				Maria I. I. I.	PM	B	.98367	,98367	,983		
		12 to 14 hours for LA***	11	Maintain voice communication with spacecraft	modes, VHF	<u> </u>	.98347	,98347 ,98402	.983		
		jųj laiki				E	.98402	.98402	.9840		
	(d) Lunar module ascent				PM modes slow	A B	.98395	.98395 .91376	.983		
	& rendezvous				TLM	c	.94459	.94459	.944.		
		1	1111	Monitor spacecraft status	PM modes normal	B	.98395 .91376	.98395 .91376	,983°		
				and systems	TLM	c	.94459	.94459	.944.		
				(e.g. verify AGC state vector following lunar orbit insertion)	FM modes	B	\	 	.983° .913		
				<u>-</u>	TV	C		\mathbf{k}	.944		
	,				TLM	В			.913		
					playback	C			.944		
					SIVR						
			IV	• • • • • • • • • • • • • • • • • • • •		A	.93788	.93788	.937		
			1	to spacecraft (e.g. transmit targeting for lunar orbit		B C	.93013	.93013	.930 .980		
				Insertion 2nd burn, transmit	PM modes	D	,95338	.95338 .97559	.953		
			1	navigation updates, transmit targeting for transearth		F	.97559 .93695	.93695	.975 .936		
L				Injection)		G	.93013	.93013	.930		
	The second secon										

^{*}AS DEFINED IN THE MSFN SUPPORT FUNCTION LIST FIG.1

^{**}DURING "OFF" PERIODS FUNCTION Y (MAINTAIN SITE PROFICIENCY) IS ASSUMED TO BE THE REQUIRED SUPPORT FUNCTION.

TABLE IV-5 LITY NOMINAL OPERATING PARAMETERS FOR MSFN AND SPACECRAFT (cont'd)

Required MSFN support functions					Overall reliability by the coverage interval (multiple sites)						
:	Required MSFN support funct	MING MORN SUPPORT TURCHORS		S - Single One spacecraft D - Dual				cocraft D	And it will be seen in succession to the facilities of	One space+ craft	Two space- craft
			*	30'-5	30'-D	851	30'-5	30'⊷D	85'	c.alı	eigii
		PM	A	.95247	.95247	.95247	.95247	.95247	.95247	.999999	,99891
j	I Determine position of spacecraft versus time (tracking/navigation)	rnging	В	.92645	.92645	.92645	.92645	.92645	.92645	.999995	.99883
		doppler	2	.96708	.96708	.96708	.96708	.96708	.96708	.999999+	.99980
	(fracking/navigation)	angle	D	.94486	.94486	.94486	,94486	.94486	.94486	.999998	.99939
11] m.,	<u> </u>	.98402	.98402	.98402 .98367	.98402	.98402	.98402	.9999994	.99995
- 11	Maintain voice communication	PM modes,	<u>B</u>	,98367 ,98347	.98367 .98347	.98347	.98367 .98347	.98347	.98367 .98347		
i	ith spacecraft	VHF	1 B	.98402	.98402	.98402	.98402	.98402	.98402		
		1 ''''	E	.98402	.98402	.98402	.98402	.98402	.98402		
		PM modes	T Ā	.98395	.98395	.98395	.98395	.98395	,98395	.999999+	,99995
Į		slow	B	.91376	.91376	.91376	.91376	.91376	.91376	.999990	,9983
i		TLM	C	.94459	,94459	.94459	.94459	.94459	,94459	.999998	.^9937
l		PM modes	A	.98395	.98395	.98395	.98395	.98395	.98395	,999999+	,99995
111	Monitor spacecraft status	normal	В	.91376	.91376	.91376	.91376	,91376	.91376	.999990	.99833
ļ	and systems	TLM	Ç	.94459	.94459	.94459	.94459	.94459	.94459	.999998	.9993 .9861
ĺ		FM modes	B	/	/_	.98395	1		.98395 .91376	,99978 ,99342	,92689
1		TV	눈		/	.94459			194459	.99744	.9533
ĺ			A	\longrightarrow	\leftarrow	.98395	$\overline{\hspace{1cm}}$	\leftarrow	,98395	.99978	.98619
ĺ		TLM	B		/	.91376		-><	,91376	,99342	.9268
ĺ		playback	1 c			.94459			,94459	,99744	.9533
ĺ						************					
i		5 I¥ 8	88.8								

I۷	to spacecraft (e.g. transmit navigation updates, transmit		A	.93788	.93788	.93"88	.93788	.93788	.93788	.999997	.9992
l		PM	B	.93013	.93013	.93013	.93013	.93013	.93013	.999996 .999999+	.9989 .9999
ĺ		modes	C	.98027 .95338	.98027 .95338	.98027	.98027	.98027 .95338	.98027 .95338	,999999	,9995
l	midcourse guidance correction targeting, transmit targeting for		1	,97559	.97559	.97559	.97559	.97559	.97559	1999999+	.9998
i	possible aborts, transmit lunar		F	.93695	,93695	.93695	,93695	.93695	.93695	999999+	.9991
1	orbit in section targeting)		G	.93013	.93013	.93013	.93013	.93013	.93013	,999996	,9989
Γ.		PM	A	.95247	.95247	.95247	.95247	.95247	.95247	,999999	.9989
'	Determine position of spacecraft versus time	rnging	В	.92645	,92645	.92645	.92.645	.92645	,92645	.999995	.9983
ĺ	(tracking/navigation)	doppler	С	,96708	.96708	.96708	.96708	.96708	.96708	,999999+	,9998
<u> </u>	(Hacking) havigation)	angle	D	.94486	,94486	,94486	,94486	.94486	.94486	.999998	.9993
		D.V.	B	.98402 .98367	.98402	.98402	.98402	.98402	.98402	.999999+	.9999
IJ	Maintain voice communication	PM modes,	- C	,98347	.98367 .98347	.98367 .98347	.98367	.98347	,98367 ,98347	 	
l	with spacecraft	VHF	1 b	,98402	,98402	.98402	,98402	.98402	.98402	 	
j] ''"	E	.98402	.98402	.98402	.98402	,98402	.98402	 	
		PM modes	A	.98395	.98395	.98395	,98395	,98395	.98395	.999999+	.9999
		slow	В	.91376	.91376	.91376	.91376	.91376	.91376	.999990	.9983
		TLM	C	,94459	,94459	.94459	.94459	.94459	.94459	.999998	.9993
		PM modes	A	.98395	.98395	,98395	,98395	.98395	.98395	,999999+	,9999
	Monitor spacecraft status	normal	В	.91376	,91376	.91376	.91376	.91376	.91376	.999990	.9983
1	and systems	TLM	C	.94459	.94459	.94459	.94459	.94459	.94459 .98395	.999998	,9993
	(e.g. verify AGC state vector following lunar orbit Insertion)	FM modes	B			.91376		/-	.91376	.99342	.9861
1	totlowing found of bit (tisetifon)	TV	c			.94459	+	 / 	.94459	.99744	.9533
			Ā		\leftarrow	.98395	 	*	.98395	,99978	.9861
1		TLM	В			.91376	/		.91376	.99342	,9263
		playback	C			.94459	Z_{-}		.94459	.99744	.9538
			***		***********	***************************************	1	•			
		SIVE					1	.		1	
117	5-1			00700	00700	00700	4	******	00700	000007	
117			HAB	.93788	.93788	.93788	.93788	.93788	,93788 .93013	.999997 .999996	.9992
ì	to spacecraft (e.g. transmit targeting for lunar orbit		1-2	.98027	.98027	.98027	.98027	.98027	.98027	.999999+	.9999
1	insertion 2nd burn, transmit	PM:	├	.95338	,95338	.95338	.95338	.95338	.95338	.999999	.9995
		modes				.97559			.97559	.999999+	.9998
		Hionez	i E	1 .9/559	1 ,7/337	1 ,7/227	1 .9/559	1 ,7/337	1 .7/227	1 177777777	1 17770
	navigation updates, transmit targeting for transearth	Modes	F	.97559	.9755 y .93695	.93695	.97559 .93695	.97559	.93695	.999999+	.9991

OFICIENCY) IS ASSUMED TO BE THE REQUIRED SUPPORT FUNCTION.

TABLE IV-6
LUNAR LANDING MISSION RELIABILITY NOMINAL OPERATING PARAMETERS FOR MSFN A

Mission	Essential data/	Duration of		m a leigmil of in	over the coverage interval S - Single						
phose	major decisions	single site coverage interval	Required MSFN support functions				One spacec	Two spacecraft			
						*	3015	30'-D	851	301-S	301
(E) Transearth	Transearth (a) Transearth Approximate				РМ	A	.95247	.95247	,95247	\	
flight	injection	10 to 14 hrs on		Determine position of	rnging	В	.92645	.92645	,92645	7	
•		10 to 14 hrs off**	1	spacecraft versus time (tracking/navigation)	doppler	C	.96708	,96708	.96708		***************************************
	(b) Earths'			(Hucking/Huvigution)	angle	D	,94486	.94486 .98402	,94486 ,98402		
	atmosphere entry				РМ	B	.98367	.98367	.98367		-
	* ***********************************			Maintain voice communication	modes,	Ċ	.98347	.98347	.98347		
			1	with spacecraft	VHF	D	.98402	.98402	.98402		
					PM modes	E	.98402 .98395	.98402 .98395	.98402 .98395	 	d
		j			slow	B	.91376	.91376	.91376		\
					TLM	C	.94459	.94459	.94459		Γ
			l		PM modes	A	.98395	.98395	.98395		1-1-
				Monitor spacecraft status and systems (e.g. verify	normal TLM	C	.91376 .94459	.91376	.91376	 	 \
	j			AGC state vector following)	Ā	1777107	177	.98395		<u> </u>
				transearth injection)	FM modes	В	Z		.91376		1/
						C	\longrightarrow		.94459	 	 / -
					TLM	B		1	.91376		 /
		j			playback	С			.94459		
						**	200000000000000000000000000000000000000				4 6000000
					214.8	6					
					538338638638638663	Ā	.93788	.93788	.93788	7	0 00000000
		j	1]	В	.93013	.93013	.93013		
			Send commands/other up data to spacecraft	PM	C	.98027	.98027	,98027	_/		
			The second secon	modes	D	.95338 .97559	.95338 .97559	.95338 .97559	-/		
				for entry carridor control)		F	.93695	.93695	.93695	/	
						G	,93013	,93013	93013	/	
(F) Entry		Approximate	1	Determine position of space- craft versus time (tracking/	PM	B	.99953	.99953	.99953		
		10 calnutes		navigation) (e.g. entry tra-	rnging doppler	는	199967	.99967	.99967	1	-
				jectory monitoring, splash point prediction)	angle	D	.99945	,99945	.99945		
				and the second s	1	<u>A</u>	.99984	.99984	.99984	 	
				Maintain voice communication	PM modes,	B C	 	 	 	 /-	
			1	with spacecraft	VHF	D					
					<u> </u>	E			60000	<i></i>	
					PM modes	B	.99983	,99983 ,99913	.99983	 	\
					TLM	<u>c</u>	,99945	.99945	.99945		Λ
					PM modes	A	,99983	,99983	.99983		17
			 	M. G.	normal	B	.99913	.99913	.99913	 	+
			111	Monitor spacecraft status and systems	TLM	H A	1.99983	.99983	.99983	 	+-}
				Alfa SASIBIIIS	FM modes	В	.99913	.99913	,99913		
			.		17	Ç	.99945	.99945	.99945		17
					TLM	B	.99983	.99983	.99983	 	
					playback	분	.99945	.99945	.99945	1	/
			1			888.98	8 888888888888		**********		
					SIV 8					/	
-			-		***************************************	Ā	.99938	,99938	.99938	*****/ ***	× 10000000
						B	.99942	.99942	.99942		
		•	1,,,	Cand annumental Astern	PM	C	.99981	.99981	.99981	/	
			1'	Send commands/other up data to spacecraft	modes	D	.99955	.99955	.99955	 /	
,				ab agin to abangulate		E	.99945	.99945	.99945	t/	+
i '	1	1	1			1	.99942	.99942	,99942		

^{*}AS DEFINED IN THE MSFN SUPPORT FUNCTION LIST FIG. 1

^{**}DURING "OFF" PERIODS FUNCTION V (MAINTAIN SITE PROFICIENCY) IS ASSUMED TO BE THE REQUIRED SUPPORT FUNCTION.

TABLE IV-6 LIABILITY NOMINAL OPERATING PARAMETERS FOR MSFN AND SPACECRAFT (cont'd)

ation of							Overall reliability over the coverage interval (multiple sives)					
gle sité ge interval		Required MSFN support function			oft D - Di	S — Single off D — Dual		cocraft D	7,700		Two space- craft	
				*	30'-S	30'-D	851	30'-5	30'-D	85'		
kimate 14 hrs on 14 hrs off**	1	Determine position of spacecraft versus time (tracking/navigation)	PM rnging doppler	A B C	.95247 .92645 .96708	.95247 .92645 .96708	.95247 .92645 .96708			= /	.999999 .999995 .999999+	\
	11	Maintain voice communication with spacecraft	engle PM modes, VHF	D A B C D E	.94486 .98402 .98367 .98347 .98402	.94486 .98402 .98367 .98347 .98402	.98402 .98367 .98347 .98402		//		.9999999+	
		and an interpretation of the control	PM modes slow TLM PM modes normal	A B C A B	.98395 .91376 .94459 .98395	.98395 .91376 .94459 .98395	.98395 .91376 .94459 .98395 .91376				.999999+ .999998 .999999+	
		Monitor spacecraft status and systems (e.g. verify AGC state vector following transearth injection)	TLM FM modes TV	A B C	.94459	.94459	.94459 .98395 .91376 .94459		X		.999998 .99978 .99342 .99744	
,			TLM playback	A B C			.98395 .91376 .94459	***************************************		\	.99978 .99342 .99744	
			5 IV 8	B C	.93788	.93788	,93788	7/			.999997	
	IV	Send commands/other up data to spacecraft (e.g. transmit targeting for entry corridor control)	PM modes	B C D E F	.93013 .98027 .95338 .97559 .93695	.93013 .98027 .95338 .97559 .93695	.93013 .98027 .95338 .97559 .93695				.999996 .999999+ .999999+ .999999+ .999996	
ximate rutes		Determine position of space- craft versus time (tracking/ navigation) (e.g. entry tra- jectory monitoring, splash point prediction)	PM rnging doppler angle	<u>А</u> В U D A	.99953 .99934 .99967 .99945	.99953 .99934 .99967 .99945	.99953 .99934 .99967 .99945			1	.99953 .99934 .99967 .99945	
•	11	Maintain voice communication with spacecraft	PM modes, VHF	A B C D E	,99984	.99984	.99984				1,77704	
	111	il Monitor spacecraft status and systems	PM modes slow TLM PM modes normal TLM	A B C A B C	.99983 .99913 .99945 .99983 .99913 .99945	.99983 .99913 .99943 .99983 .99913 .99945	.99983 .99913 .99945 .99983 .99913 .99945				.99983 .99913 .99945 .99983 .99913 .99945	
			FM modes TV TLM playback	B C A B	.99913 .99945 .99983 .99913	.99913 .99945 .99983 .99913	.99913 .99945 .99983 .99913				.99913 .99945 .99983 .99913	
			SIV 8									
	IV	Send commands/other up data to spacecraft	PM modes	A B C D E F	.99938 .99942 .99981 .99955 .99975 .99945	.99938 .99942 .99981 .99955 .99975 .99945	.99938 .99942 .99981 .99955 .99975 .99945				.97738 .99942 .99981 .99955 .99975 .99945	

LIST FIG. 1

IN SITE PROFICIENCY) IS ASSUMED TO BE THE REQUIRED SUPPORT FUNCTION.

- 1.) Launch, Earth Parking Orbit
 - a) Coverage (Discontinuous)

 Minimum number of sites, one, 85 ft or 30 ft antenna
 Typical number of sites, two or more in certain regions
 - b) Typical time interval of coverage by one site, 8 minutes
- 2.) Translunar Injection (TLI)
 - a) Coverage (Continuous)

 Minimum number of sites, two 30 ft antenna dual sites, (one a ship)

 Typical number of sites after TLI, one 85 ft site and wing site, three
 30 ft antenna dual sites (one a ship)
 - b) Typical time interval of coverage by one site, TLI approx. 5 minutes, 9 hours following TLI
- 3.) Transposition and Docking, S4-B Separation (T and D)
 - a) Coverage (Continuous)

 Minimum number of sites, one 85 ft antenna site with wing site, three 30 ft antenna dual sites (one a ship)

 Typical number of sites, same as above for about 4 hours after transposition and docking, then additional coverage available
 - b) Typical time interval of coverage by one site, T and D approx. 2 hours, 7 hours following T and D
- 4.) Translunar Flight
 - a) Coverage (Continuous)
 Minimum number of sites, one 85 ft antenna site and wing site, two 30 ft antenna dual sites
 Typical number of sites, one 85 ft antenna site and wing site, two 30 ft antenna dual sites, and two 30 ft antenna single sites
 Maximum number of sites, two 85 ft antenna sites and wing sites, two 30 ft antenna dual sites, and six 30 ft antenna single sites
 - b) Typical time interval of coverage by one site, 12 hours (Over a 12 hour interval the continuous coverage will be by the minimum number of sites for approximately 2 hours, the typical number for approximately 8 hours, and the maximum number for approximately 2 hours)

Figure 2-Approximate Summary of MSFN Coverage for a Lunar Mission

- 5.) Prior to Lunar Orbit Insertion
 - a) Coverage (Continuous)
 Typical number of sites, one 85 ft antenna site with wing site, three
 30 ft antenna dual sites
 - b) Typical time interval of coverage by one site, 3 to 9 hours prior to lunar occultation

6.) Lunar Orbit by CSM, Lunar Stay by LM

- a) Coverage (Continuous for LM, discontinuous for CSM due to lunar occultation)
 Minimum number of sites, one 85 ft antenna site and wing site, two 30 ft antenna dual sites
 Typical number of sites, one 85 ft antenna site and wing site, two
 - 30 ft antenna dual sites and two 30 ft antenna single sites, Maximum number of sites, two 85 ft antenna sites and wing sites, two 30 ft antenna dual sites, and six 30 ft antenna single sites
- b) Typical time interval of coverage by one site
 - i) For LM, 12 hours
 - ii) For CSM, 1.2 hours on, 0.8 hours off due to lunar occultation (As for the translunar and transearth phases, over a 12 hour interval the continuous coverage will be by the minimum number of sites for approximately 2 hours, the typical number for approximately 8 hours, and the maximum number for approximately 2 hours)
- 7.) LM Touchdown on Lunar Surface, LM Ascent and Prior to Rendezvous
 - a) Coverage (Continuous)

 Maximum number of sites, two 85 ft antenna sites and wing sites, three 30 ft antenna dual sites, two 30 ft antenna single sites
 - b) Typical time interval of coverage by one site,
 Approx. 1 hour during LM descent including lunar touchdown, 10 hours following lunar touchdown
 Approx. 1 hour following LM ascent to lunar occultation
- 8.) Prior to Transearth Injection
 - a) Coverage (Discontinuous)
 Typical number of sites, one 85 ft antenna site and wing site, two
 30 ft antenna dual sites, and four 30 ft antenna single sites
 - b) Typical time interval of coverage by one site, Approx. I hour prior to lunar occultation

- 9.) Transearth Flight
 - a) Coverage (Continuous)
 Same as for translunar flight
 - b) Time interval of coverage by one site Same as for translunar flight
- 10.) Entry
 - a) Coverage (Discentinuous)

 Typical number of sites, one 30 ft antenna site, single or dual
 - b) Typical time interval of civerage by one site, approx. 5 minutes

Figure 2 (continued)—Approximate Summary of MSFN Coverage for a Lunar Mission

One Spacecraft	20 MHz Local Oscillators	Reference Loops	Ranging Systems	TLM Receivers	Antennas* per Spacecraft		
Coverage by:	per Spacecraft	per Spacecraft	per Spacecraft	per Spacecraft	PM Modes	FM Modes	
1 85 ft antenna site and wing site, 1 30 ft antenna dual site	6	12	6	12	3	2	
1 85 ft antenna site and wing site, 2 30 ft antenna dual sites, 2 30 ft antenna single sites	10	20	10	20	6	2	
2 85 ft antenna sites and wing sites, 2 30 ft antenna dual sites, 6 30 ft antenna single sites	18	36	18	36	12	4	
Two Spacecraft Coverage by:	,						
1 85 ft antenna site and wing site, 1 30 ft antenna dual site	3	6	3	6	1.5	1	
1 85 ft antenna site and wing site, 2 30 ft antenna dual sites, 2 30 ft antenna single sites	5	10	5	10	3]	
2 85 ft antenna sites and wing sites, 2 30 ft antenna dual sites, 6 30 ft antenna single sites	9	18	9	18	12	2	

Figure 3-Summary Table of Certain Unified S-Band Equipment per Spacecraft

Mode (PM)	Site	100 mi	1000 mi	10,000 mi	50,000 mi	100,000 mi	240,000 mi
[†] 2) Carrier, PRN Ranging	A) 85 ft Antenna Cooled Paramp)	entropy of the second	\			
Voice Normal TLM	B) 30 ft Antenna Cooled Paramp		\	1	\	•	1,7
(51.2 kbs)	C) 30 ft Antenna Uncooled Paramp	na in camena	######################################	,	e de gran i gran d'alla d'ana	e i i i mer ere ere ere ere ere ere ere ere ere) x
4) Carrier, Voice, Slow	A) 85 ft Antenna Cooled Paramp	• • • • • • • • • • • • • • • • • • •	A spillare del l'appropriate del l'appropriet de l'appropriet	A THE PARTY	\ \	and the second second	\
TLM (1.6 kbs)	B) 30 ft Antenna Cooled Paramp	1		esercente e esercente. V	V	* *************************************	
(1.0 KD3)	C) 30 ft Antenna Uncooled Paramp	,	\	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	1	\
9) Carrier, PRN Ranging,	A) 85 ft Antenna Cooled Paramp	V.	\	A SECURIT OF THE PROPERTY OF T	/ 	1	١
Slow TLM, (1.6 kbs)	B) 30 ft Antenna Cooled Paramp	\	V	\			\
	C) 30 ft Antenna Unccoled Paramp	V		\	- ringalanguránokai ká khala	,	
5) Carrier, Slow TLM	A) 85 ft Antenna Cooled Paramp	\	\	\ 	ne sinatagi na kata diak diak	A CONTRACTOR DESCRIPTION	\
(1,6 kbs)	B) 30 ft Antenna Cooled Paramp	V	\ 	e elektriski moo eksisseki magaga	,	\ 	<u> </u>
nngganthalalan (1884) (1864 bird) (1884 bird) (1884 bird) (1884 bird) (1884 bird)	C) 30 ft Antenna Uncooled Paramp	**************************************	\ 				· ·
7) Carrier, PRN Ranging	A) 85 ft Antenna Cooled Paramp	\	\	n man a seriente de comm			
	B) 30 ft Antenna Cooled Paramp	V	<u> </u>	\	· · · · · · · · · · · · · · · · · · ·		V
negyinin telepantan kanala kanala kanala kanala kanala kanala kanala kanala kanala kanala kanala kanala kanala	C) 30 ft Antenna Uncooled Paramp	V	\	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \		· ·	V.
#10) Carrier, Back Up	A) 85 ft Antenna Cooled Paramp	V	\	· · · · · · · · · · · · · · · · · · ·	The second second second second	on the second second on the se	V
Voice	B) 30 ft Antenna Cooled Paramp	V	<u>\</u>		· ·	V	V
7511	C) 30 ft Antenna Uncooled Paramp	V	\ 	V CAMPACIAN DESCRIPTION	Make the transfer of the state	V.	V
Mode (FM) #1) Playback, Voice, CSM	A) 85 ft Antenna Cooled Paramp	V	V				
TLM, Scientific	B) 30 ft Antenna Cooled Paramp	ν	\ 	X	X	X	X
Data	C) 30 ft Antenna Uncooled Paramp	V	٧	X	X	X	X
#4) Television	A) 85 ft Antenna Cooled Paramp B) 30 ft Antenna	V	L V	V COMPANY OF THE PARTY OF THE P	V	V	
	Cooled Paramp C) 30 ft Antenna	V.	<u> </u>	X	X	X	X
	Uncooled Paramp	V.	V	X	X	Х	X

Maryins are based on a TLM signal to noise ratio for 10^{-6} bit error probability, voice signal to noise ratio of 10 db for 90% word intelligibility and a PRN ranging signal to noise ratio of 0 db for 1 minute of integration.

Figure 4-Representative Mode Support for the Unified S-Band System with Adequate Signal Margin for Nominal MSFN and Spacecraft Parameters

 $[\]sqrt{\ }$ adequate signal margin, mode can be supported $\sqrt{\ }$ no signal margin, mode degraded but could probably be supported X node cannot be supported

REFERENCES

- 1. Lunar Orbital Mission Reliability Study Included in; October-December 1968 Quarterly Progress Report of the Manned Space Flight Network Study Program, Space Communications Group (CSC), Johns Hopkins University/Applied Physics Laboratory and Included in; Performance Evaluation of the Unified S-Band Ground System for AS-205, X-834-68-485, NASA, Goddard Space Flight Center
- 2. NASA, MSC Internal Note No. 68-FM-196, August 9, 1968 Apollo Mission G Spacecraft Reference Trajectory, Volume I, Reference Mission Profile (Launched August 14, 1969)

APPENDIX I

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This appendix contains histograms of the total number (over the five missions status periods) of reported failures and repair times for some of the on site equipment categories. Included specifically are the Unified S-Band and 642-B computer areas.

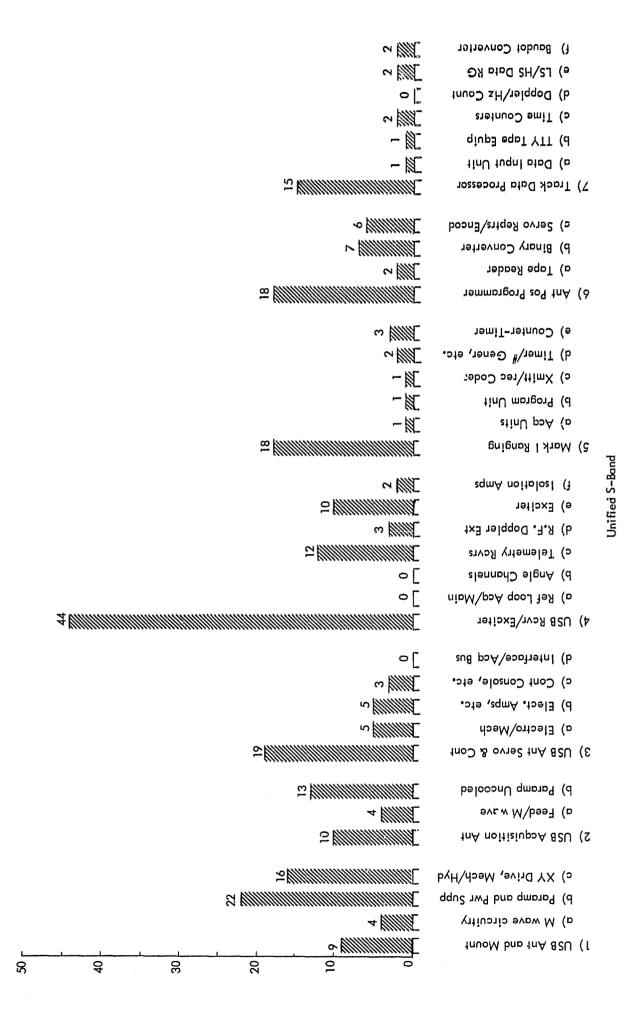


Figure Al-1-Equipment Subsystem Cumulative Failures for Missions AS-204, 205, 501, 502, 503

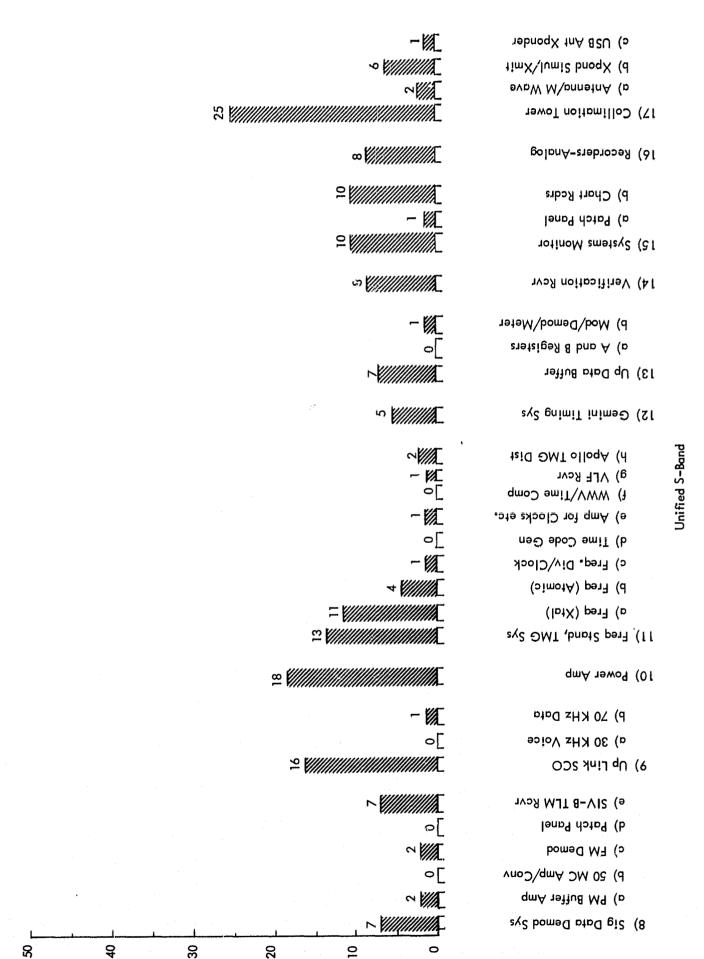


Figure AI-2—Equipment Subsystem Cumulative Failures for Missions AS-204, 205, 501, 502, 503

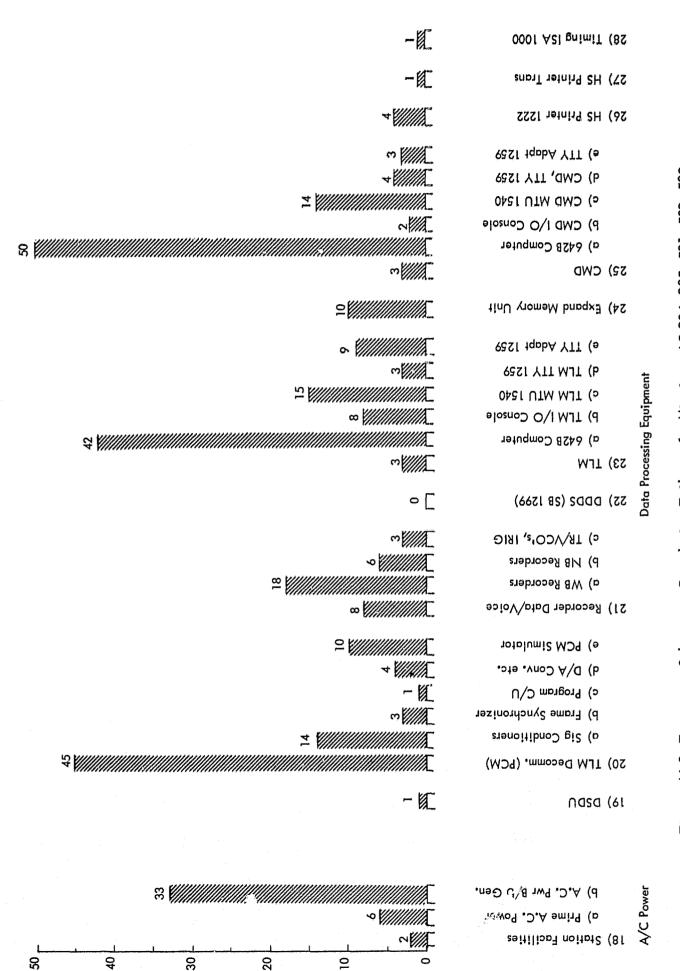


Figure Al-3-Equipment Subsystem Cumulative Failures for Missions AS-204, 205, 501, 502, 503

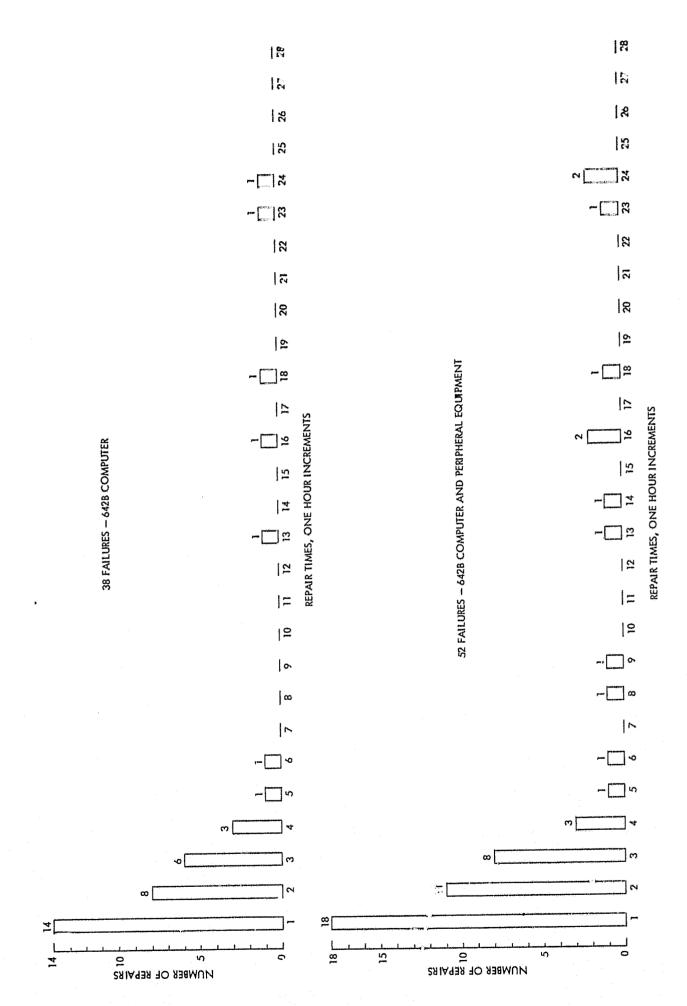


Figure Al-4—CMD 642B Computer and Peripheral Equipment Failures Repaired Within the First 28 Hour Period

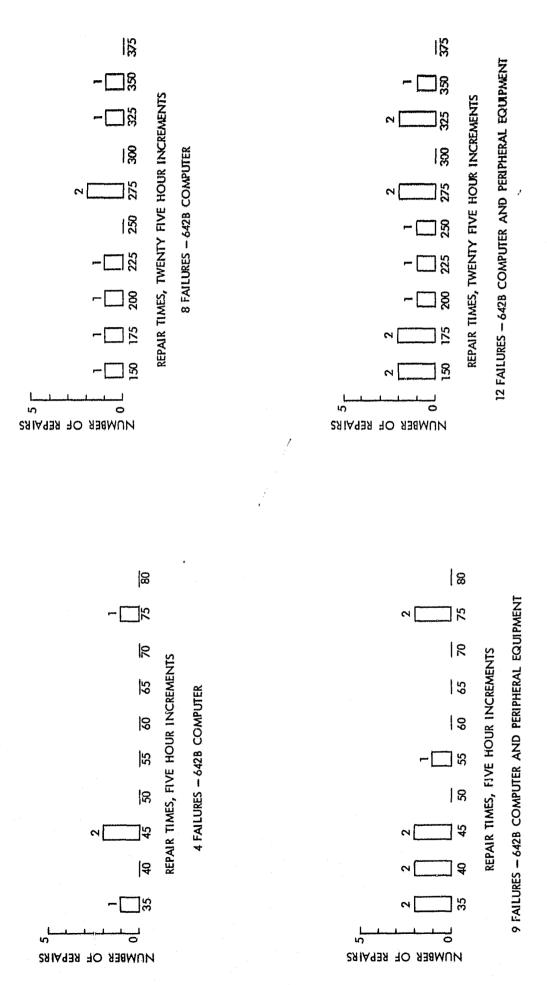


Figure AI-5... CMD 642B Computer and Peripheral Equipment Failures Inoperative for More than 30 Hours

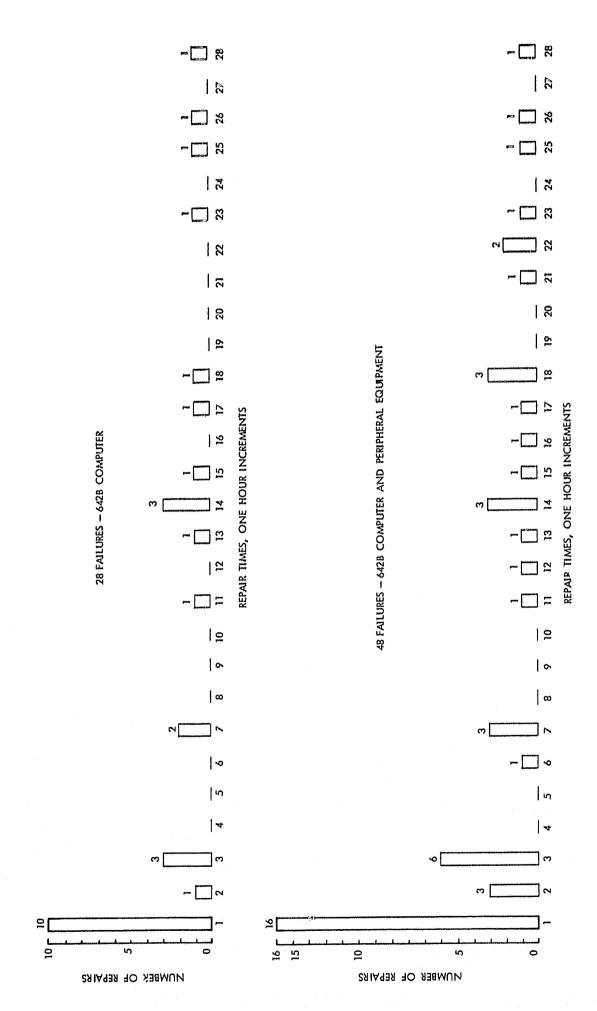


Figure Al-6-TLM 642B Computer and Peripheral Equipment Failures Repaired Within the First 28 Hour Period

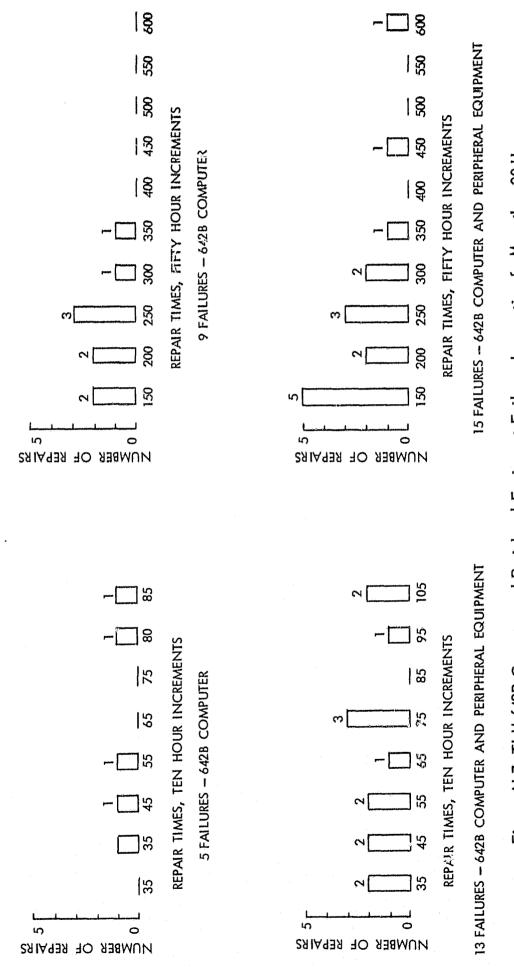


Figure AI-7-TLM 642B Computer and Peripheral Equipment Failures Inoperative for More than 30 Hours

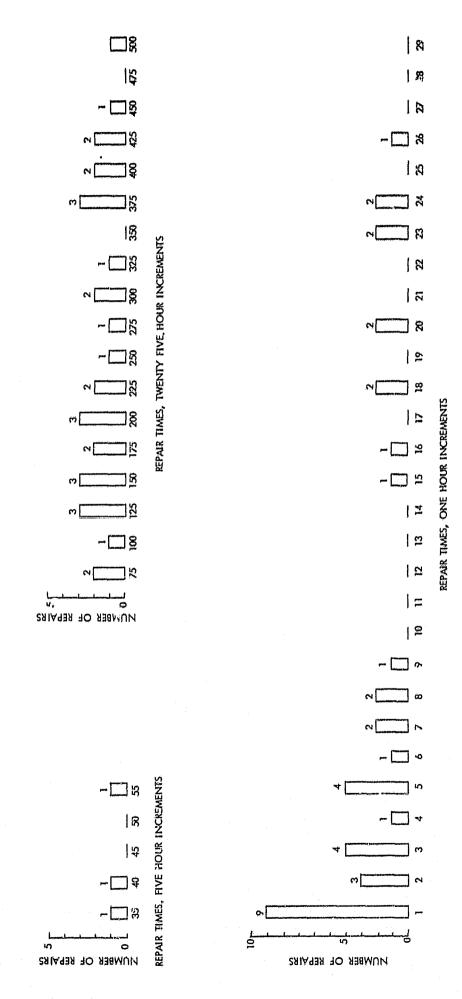


Figure Al-8-USB Receiver/Exciter Equipment Histogram of Repair Times